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 **WORKING PAPERS**

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of the Sugar Cartel in  
Austria–Hungary**

**Nikolaus Fink**

**508/2016**

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## **Abstract**

This paper studies the legal sugar cartel in Austria–Hungary in 1891–1914. I analyse the cartel formation prior to 1891 that was enabled by an excise tax. The cartel started with simple annual quotas and – despite breakdowns – learned to adapt to inventory demand, entry, internal coordination problems and lowered import protection. Detailed qualitative evidence on the inner workings and prices, opportunity costs and sales data on a monthly basis are discussed. The success of the cartel at subsequent stages is evaluated.

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# Formation and Adaptation of the Sugar Cartel in Austria-Hungary\*

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## Abstract

This paper studies the legal sugar cartel in Austria-Hungary in 1891-1914. I study the cartel formation prior to 1891 that was enabled by an excise tax. The cartel started with simple annual quotas and—despite breakdowns—learned to adapt to inventory demand, entry, internal coordination problems and lowered import protection. Detailed qualitative evidence on the inner workings and prices, opportunity costs and sales data on a monthly basis are discussed. The success of the cartel at subsequent stages is evaluated.

**JEL Classification:** H2, L13, L41, N83, L66

**Keywords:** Cartels, Collusion, Sugar Industry, Storage

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# 1 Introduction

This paper studies a unique combination of narrative and quantitative evidence on formation and organizational learning of a cartel under varying conditions—the sugar industry in Austria-Hungary. I present a sequence of events on failures to collude followed by successful collusion, errors in optimal collusion followed by more profitable collusive strategies and reactions to changes in the external environment that kept collusion stable despite larger incentives to deviate.

The industry failed to cartelize in 1864, 1873/74 and 1884-1886, but succeeded from 1891 onwards with breakdowns in 1894/95 and 1903-1906. At subsequent stages, the cartel learned to fix monthly quotas, integrate upstream raw sugar factories, centralize sales and impede outsiders and imports via retroactive exclusivity rebates. Empirical evidence is based on commodity market prices and monthly sales data measured and taxed at the gate of the sugar refineries. I decompose the sales data into trend consumption, seasonal as well as demand anticipating inventory demand. Sophisticated but simple aggregation essentially smoothes sales data closer to actual consumption. I find an inelastic demand and I am able to relate the cartels' pricing power to the internal and supply-side based challenges the cartel often addressed later on. In terms of the threat of imports—the competitive constraint essentially outside Austria-Hungary's direct influence due to a multilateral trade agreement limiting the import duty—the cartel steadily improved.

The sequence of events also includes the interaction with the government—the introduction of the excise tax, the failure of the first draft antitrust laws, the Brussels Convention as the first multilateral trade agreement and the failed state-supported cartel in 1903 all affected the industries' organization. Reverse, the cartel lobbied in order to influence the media and the government.

The sugar industry was so well documented since it was the most important single industry in the late 19<sup>th</sup> century. Already Menger's second chapter of "Grundsätze der Volkswirtschaftslehre" (1871) refers to sugar inventories, worldwide production areas,

expected yields, weather conditions, number of raw sugar factories and refineries, technological progress, traffic hold-ups and delivery times when talking about forecasts on available quantities to fulfil demand. Market reports, the archive of the sugar taxing Austrian ministry of finance, industry and economic journals (Griffin (1902), for example), newspapers, most of the cartel agreements themselves and other publications that provide extremely well-documented evidence on taxation and cartelization.

I contribute to the literature on the inner workings of cartels in several ways. First, I show how the introduction of the excise tax enabled collusion. Second, I present unique long-term evidence on cartel formation and adaptation and on its interaction with the government. Third, I relate empirical data on sales and different inferred storage patterns as well as estimated cartel overcharges to a cartel at subsequent stages. In general, such evidence and variation is rare or even non-existent in today's world of antitrust laws and also in the existing literature and therefore interesting in itself. Real world examples may help to refine and reassess the theory on collusion. And a better understanding of cartels may improve antitrust practice.

The existing literature is summarized by Levenstein and Suslow (2006). Cartels invest in the organizational structure in order to implement an individually rational and collusive strategy, to detect and deter deviations and to prevent competition from outsiders. But information on dynamic organizational learning of cartels is limited and confined to a small number of case studies. Parts of the literature are specifically relevant to understand the inner workings of the sugar cartel in Austria-Hungary: On the monitoring within cartels, Harrington and Skrzypacz (2007) and more recently Harrington and Skrzypacz (2011) develop models where deviators and non-deviators are treated asymmetrically; within the latter model, sustaining collusion requires truthful reports of cartel members—wrong reporting ultimately leads to reversion to competitive prices. Genesove and Mullin (2001) analyze the US Sugar Institute that solely fixed business practices from 1927 to 1936. The cartel relied on ex-ante notification of conduct and frequent (weekly) meetings and reports in order to detect secret actions with minimal delay. Retaliation was limited

to verifiable deviations in order to minimize improper punishment. Often, deviating practices were simple matched. Genesove and Mullin do not observe renegotiations of punishments, the frequent meetings were rather used to adapt the collusive agreement. One of the main problems was that external sales agents with high powered incentives did often cheat and deviate from the institute's collusive rules. In summary, they argue that the Sugar Institute pursuit the common goal of collusion; but each member was well aware of their incentives to cheat; thus the inner workings' main aim was to solve the contracting problem. Anton and DasVarma (2005) analyze equilibria in markets with storable goods and find that an oligopolistic market structure may lead to an increasing price path and rational in-advance purchases by buyers. Dudine et al. (2006) study a monopoly selling a storable good and find that a monopolist who credibly announces current and future prices does not induce storage, whereas for a monopolist without commitment consumers anticipate a price increase in the future and engage in storage. Asker and Bar-Isaac (2014) study vertical practices and find equilibria with exclusionary practices and rewarding kick-back transfers. Hyytinen et al. (2015) and Fink et al. (2015) study a cross section of different cartels and present facts how these collusive strategies were implemented and which level of information exchange was required. Salvo (2010) empirically finds that potential entry limited market power of Brazilian cement producers.

The paper is organized as follows. Section 2 presents the required background information on sugar, the Austro-Hungarian Empire and the trade and tax regime. A central part of the article is section 3 that presents evidence on industry and cartel behavior. Starting in 1864, I describe the origin of the tax reform in 1888 and the emerging structure of the industrial organization of the sugar industry until 1914. Section 4 documents the available quantitative information—basically prices and sales data. In section 5 I estimate a demand elasticity and document different patterns in stock-piling and demand anticipation. In Section 6 I present simple estimated means for the cartel overcharge for different kinds of cartels. Finally, I discuss the central results and relate my findings to the existing literature.

## 2 Background on Industry, History, Trade and Tax

Here I present the properties of sugar and basics of its production technique, information on Austria-Hungary and some basic information on industry concentration and importance of the industry.

**Industry and production technique.** Refined sugar is a relatively homogenous product made of sugar beets or sugar cane. Sugar is not perishable and of little bulk so that transport costs are sufficiently low. In Europe, sugar beets were planted in the spring and harvested in the autumn. After the harvest beets were hauled to a raw sugar factory. Beets were superposable for some time, but then would lose sugar content. Therefore, mostly from October until January, sugar beets had to be processed to raw sugar. Raw sugar was superposable and contained around 88-92% of sucrose. Due to a peculiar and not so pleasant taste, it was not directly consumable. However, raw sugar was traded worldwide. In order to create consumable sugar, it was necessary to refine the raw product. This was done within sugar refineries mainly from October to April but also to a small degree during May to September. Inventories of refined sugar normally peaked in February and reached a trough in September. As a final product, refined sugar was white and contained nearly 100% sucrose. Refined sugar was traded worldwide, too; but to a lesser degree than raw sugar, since the refineries were often located in the countries that consumed sugar such as the United Kingdom.<sup>1</sup>

**Political and general economic background.** Austria-Hungary is depicted in Figure 1. It was a constitutional monarchic union between the Crown of the Austrian Empire and the Kingdom of Hungary in Central Europe, that existed from 1867 to October 1918. It was a multinational realm, and, after the Russian empire, geographically the second largest country in Europe, and the third most populous. Modern-day nation states that formerly belonged to the empire include Austria, Hungary, Slovenia, Bosnia

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<sup>1</sup>See Stammer (1887) for the historical production technology.



Figure 1: Austria-Hungary



Source: Mariusz Paździora (2008).

Notes: Vienna and Budapest were the capitals of Austria-Hungary. Ústí at the river Elbe in the very north-west of the map was a river port and important railway junction. Trieste in the south-west was the most important port of Austria-Hungary. In Chropyně—not in the map but about 70 km east of Brno—a commonly-run sugar refinery is situated.

and Herzegovina, Croatia, the Czech Republic, Slovakia, large parts of Serbia and Romania, and smaller parts of Italy, Montenegro, Poland and Ukraine. Austria-Hungary adapted the gold standard in 1892 and introduced the Krone (K) as a currency.<sup>2</sup>

The sugar industry was the single most important industry during that time. The export of sugar amounted to 7.5-10% of total foreign trade between 1885 and 1910.<sup>3</sup> The first factory in Austria had been established in 1828. The industry association was established in 1854. Sugar consumption rose from 1 kilo per capita in 1852 to 13 kilo in

<sup>2</sup>Before the gold standard, the florin was the domestic currency. Since the analysis covers the period from 1888 to 1914 on, the Krone is chosen as a currency.

<sup>3</sup>Rudolph (1973)

1913. In the early phase, the industry was highly competitive. For the relevant period, there existed 150 to 200 raw sugar factories. The empire-wide Herfindahl-Hirschman Index (HHI—a measure of size of firms relative to the size of the industry) was below 200, thus concentration was very low; the largest market share was below 5%. For the refineries' industry, 30 to 60 refineries were observed. The HHI was below 800, and the largest market share was below 20%. Two thirds of the sugar factories were in Bohemia. The importance of Hungary rose after the tax reform in 1888. Before that, Hungary was not competitive since the sugar content of beets was low and the weight of beets and not sugar was taxed. The sugar industry was also of high importance for regional and rural industrialization. Beets, sugar as well as coal were transported to and from sugar factories and refineries. Thus factories and refineries were often situated at railways and influenced the development of the railway network in the rural areas.<sup>4</sup>

**Industry protection and taxation.** My analysis mainly focuses on the period August 1888 to July 1914. On August 1<sup>st</sup>, 1888 there was a change of the trade and tax regime. An excise tax amounting to 22 K per 100 kg was introduced and the export bounty for refined sugar was fixed at 4.6 K per 100 kg, for raw sugar at 3.2 K. For the production of 100 kg of refined sugar 111 kg of raw sugar were necessary.<sup>5</sup> Thus the export of 100 kg of refined sugar was subsidized with 4.6 K whereas the export of the equivalent amount of raw sugar (111 kg) was subsidized only with 3.552 K.<sup>6</sup> The export of refined sugar was thus favored relative to the export of raw sugar by an additional bounty of 1.048 K. The import duty was kept at 24.12 K per 100 kg for refined sugar. In order to give a rough feeling for the size of the tax, the bounty and the duty, the price at the export market for refined sugar was within the range of 20 and 60 K for 100 kg for the analyzed period. The tax increased in July 1896 to 26 K and to 38 K in August 1899—thus the tax often surpassed 100% of the export price on the world market.

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<sup>4</sup>See Schaal (2005)

<sup>5</sup>Hromada (1911, p. 54)

<sup>6</sup>3.2 times 0.111/0.1 = 3.552 K.

The sugar industry was highly protected. Already in 1849 there was a tariff on imported sugar.<sup>7</sup> In 1859, the industry successfully lobbied for an export bounty that was granted from 1860 onwards.<sup>8</sup> Internationally, a trade war on sugar was ongoing already at that time. For some years, multilateral trade agreements temporarily adjourned the trade war—but Austria-Hungary did not participate and kept its protective regime. Finally, a multilateral agreement for sugar was signed on March 5<sup>th</sup>, 1902. The so called Brussels Convention took effect on September 1<sup>st</sup>, 1903. All main European producers and the United Kingdom took part in the convention. The treaty prohibited all sugar bounties and limited the import duties to 6 French Francs which is 5.7 K per 100 kg for Austria-Hungary.<sup>9</sup> The Brussels Convention was prolonged and continued to exist until World War I broke out in 1914.<sup>10</sup> Thus, imports as a disciplining competitive force limited the leeway for the exercise of market power on the domestic market. Furthermore, the subsidies in favor of exporting refined sugar were abolished. There was no further switch in the tax and trade regime until the beginning of World War I in late July 1914.

### 3 Evidence on Cartel Behavior

In this section I present the evidence on cartel behavior in an overview. The 50<sup>th</sup> anniversary publication of the sugar industry association in 1904 provides information stretching back to 1854. The main focus is on the years 1888 to 1914, where I rely on detailed sources such as the weekly industry journal, daily newspapers of that time<sup>11</sup> and specific publications on the sugar industry such as a dissertation or a formal investigation in parliament in 1912.<sup>12</sup> Genesove (2015) surveys the use of history in industrial organization and stresses some potential biases—which documents have survived, which communi-

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<sup>7</sup>Centralverein (1904, p. 73)

<sup>8</sup>Centralverein (1904, p. 79)

<sup>9</sup>Due to the gold standard, 1 Austrian Krone (K) was 1.05 French Francs.

<sup>10</sup>Pigman (1997)

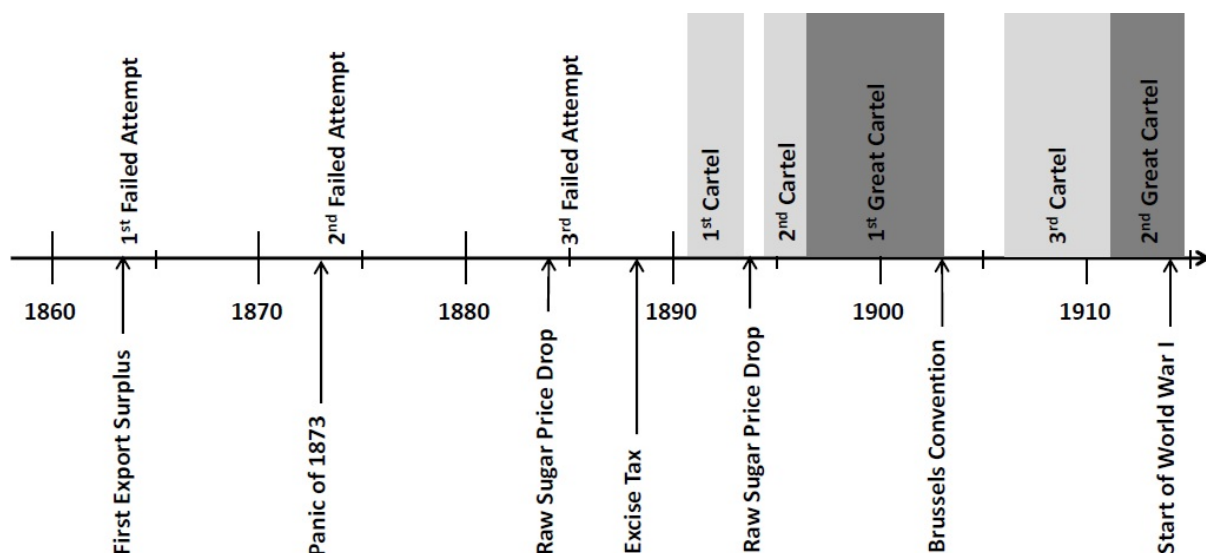
<sup>11</sup>anno.onb.ac.at offers a rich archive on historical newspapers.

<sup>12</sup>Resch (2002) provides a recent survey on cartels at that time that includes a chapter on the sugar cartel. Kohl and Steiger-Moser (2014) provide a broad collection of stories and evidence on the sugar industry in Austria.

cation and information was documented by the industry or its observers (for example, media subject to bribes) and what the historian deemed relevant. In order to address these risks, I rely on documents both supporting and opposing the cartel.

Figure 2 depicts the considered timeline. In the following subsection, I start with the failed attempts to cartelize prior to 1888. Next I explain why the introduction of the excise tax in 1888 was decisive for the formation of the cartel. Then I describe the cartels—first those before 1903 and second those after 1903 when the Brussels Convention took effect and lowered the import protection. Table 1 summarizes the agreed rules on sales of sugar.

Figure 2: Timeline of Cartel Behavior



Notes: The light gray areas cover the first, second and third cartel solely among refineries. The dark gray areas cover the first and the second great cartel. A detailed description is found below.

### 3.1 Failures to cartelize before 1888

Until 1864 consumption of sugar surpassed domestic production. Thus the price for imported sugar at the border plus the protective duty plus the transport cost determined the domestic price level. In 1864 domestic production surpassed consumption and determined the price level. An immediate attempt in 1864 to cartelize via an export association failed. It was planned to pay an export premium among cartel members to reduce domestic sup-

ply and raise—as a consequence—domestic price. According to the documents, large factories opposed the cartel.<sup>13</sup> When a severe macroeconomic crisis hit the monarchy in 1873/74, the next cartelization attempt failed already at collecting reliable production statistics.<sup>14</sup> In 1884-1886—when a crash of world wide sugar prices hit the industry—sugar refineries tried to restrict production and to establish a bonus/malus system for the purchase of raw sugar which deviates from the industry standard quality. Refineries were not able to sustain collusion,<sup>15</sup> with only limited evidence why these cartels failed.

### 3.2 Excise Tax as a Basis for Cartel Formation

The tax reform in 1888 was decisive for cartelization. The monitoring mechanisms of all successful sugar cartels were based on the excise tax. Excise taxes are selective taxes on the sale or use of specific goods and services, such as alcohol and gasoline (Hines, 2008).

**Before the tax reform 1888** The cartelization attempt in 1873/74 failed as there was no reliable information on the production quotas of the competitors. Sugar producers had not disclosed their true production because they were afraid to pay higher taxes: From 1865 on, sugar taxation was based on capacity. A certain utilization was assumed to estimate production as a tax base. The effective utilization surpassed the assumed one, so effective taxation was below the planned one. A disclosure of true production to the cartel would have increased the risk that tax authorities learned about true production and thus the risk of a sugar tax reform obligating the industry to pay higher taxes. Thus, in 1873/74, true sugar production of individual refineries' was private information both to cartel management as well as tax authorities.

Eduard Siegl was the main proponent of cartelization in 1873/74. He failed due to lack of public production data and the low willingness to provide private data. In 1880, he joined the tax administration. One year earlier, he had proposed the reform towards an

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<sup>13</sup>Centralverein (1904, p. 63)

<sup>14</sup>Centralverein (1904, pp. 63-64)

<sup>15</sup>Centralverein (1904, p. 65)

excise tax on the sold quantity of sugar and promised beneficial effects for the ministry of finance as well as the industry.<sup>16</sup> When the excise tax took effect in 1888, he had become director general for sugar taxation.<sup>17</sup> The industry itself had asked for strict control supported by fines based on criminal law<sup>18</sup> and it had accepted the necessary investment to secure effective taxation—for example, two meter tall walls had to be built around sugar factories. Tax authorities were staffed with former sugar industry experts. Sugar tax administration was effective from 1888 onwards—tax evasion and avoidance ended.<sup>19</sup> To sum up, the industry and the government had identified their common interest in verified production data as a base for cartelization and taxation—implementation was effective and represented a success for both. The explanatory remarks of the law explicitly stated that the excise tax helped to put the tax burden on the consumer and that the exact and reliable statistics could not be achieved with another taxation system.<sup>20</sup> Upon request of the industry, aggregate sales were published on the 10<sup>th</sup> of each month for the preceding month.<sup>21</sup> In order to further improve monitoring, daily reporting of prices at the commodity exchanges was introduced in 1888.<sup>22</sup>

### 3.3 Cartelization during the Protective Duty Regime

**Steps to the first quota agreement.** The excise tax enabled monitoring from 1888 onwards. It took some time to organize the sugar industry and to form the cartel. Ideas to form a cartel had been expressed regularly. For example, in March 1888 an article in the weekly industry journal pointed out the low margin of refineries and cartels in other countries as role models.<sup>23</sup>

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<sup>16</sup>Siegl (1879)

<sup>17</sup>His career was remarkable—especially given the fact that he was imprisoned for five years as a young man for participating in revolutionary riots against the emperor in 1848 (Öst.Akad.d.Wissenschaften, 2005).

<sup>18</sup>Centralverein (1885, Nr. 24)

<sup>19</sup>Auspitz (1904)

<sup>20</sup>w/o (1886, p. 469)

<sup>21</sup>Centralverein (1888, Nr. 39)

<sup>22</sup>Hromada (1911, p. 53)

<sup>23</sup>Centralverein (1888, pp. 211-212). The article explicitly referred to the American Sugar Trust. According to Genesove and Mullin (1998) the American Sugar Refining Company was formed in December

In April 1888 sugar refineries agreed on two rules in order to limit production and support higher prices: First, refineries stopped operating in May. Second, sales below the current price and forward trading were banned.<sup>24</sup> In the 1870s and 1880s, it was common practice to sell refined sugar on the basis of forward trading agreements for the whole year, thus until August or September—just before the new season started.<sup>25</sup> In February 1889 another meeting of sugar refineries took place. Rudolf Auspitz—an economist<sup>26</sup>, a sugar producer and a member of parliament—wrote that there was a plan to form a sugar cartel among refineries in order to secure a stable margin. He pointed to the threat of entry by raw sugar factories with low quality refined sugar that limited hypothetical pricing power of a cartel among refineries.<sup>27</sup> In July 1890, sugar refineries exchanged production data in order to identify the necessary restriction on domestic supply.<sup>28</sup> In April 1891, an association of sugar refineries (“Verein oesterr-ungar. Zuckerraffineure”) was formed. The association held a meeting of all members. Again, it was agreed to stop forward trading.<sup>29</sup>

**First quota agreement in 1891.** On July 8<sup>th</sup>, 1891, a first cartel among all refineries within the monarchy—organized within the association of sugar refineries—was signed for October 1<sup>st</sup>, 1891, to September 30<sup>th</sup>, 1892. Total sales to the domestic market were restricted to 230,000 tons for the whole period and allocated to the 31 refineries in three regions—Bohemia, other sugar refineries in the rest of Austria, and Hungary. Until March 1<sup>st</sup>, 1892, the cartel had to decide whether the planned sales were to be increased further. Any additional sales had to be distributed to outsider refineries and all cartel members except Hungarian refineries.<sup>30</sup> Such changes in the total production quota re-

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1887.

<sup>24</sup>Centralverein (1888, Nr. 15)

<sup>25</sup>Handels- und Gewerbekammer Prag (1896, p. 82)

<sup>26</sup>Auspitz and Lieben (1889) is regularly cited for the Auspitz-Lieben-Edgeworth-Pareto complementarity.

<sup>27</sup>Centralverein (1889, pp. 177-178)

<sup>28</sup>Centralverein (1890, p. 393)

<sup>29</sup>Centralverein (1891, pp. 210-211)

<sup>30</sup>Hungarian refineries had received a larger share in the initial allocation plan.

quired a two-thirds majority in the plenary meeting of the association. Refineries had to report their output—including shipments to warehouses—based on the tax bill on the third of each month. For surveillance, the cartel had the right to access the tax books of individual members. As a compensation payment for an excess or shortfall of individual sales, 20 K per 100 kg of sugar (exceeding the realized cartel overcharge) had to be payed to / were returned by the cartel.<sup>31</sup> In order to support the quantity fixing, the refineries had also agreed on common sales terms and seemingly the price was informally fixed, too. The agreement was prolonged until September 30<sup>th</sup>, 1894. One source says that the agreement was taken seriously by all members only in the last year (1893/94).<sup>32</sup>

**Break-down in 1894/95.** The first cartel broke down in the period of 1894/95 due to a number of reasons. New refineries were in the process of being built. Existing refineries that were specialized on the export of refined sugar asked for a quota on the domestic market. Some raw sugar factories planned to establish their own sugar refinery. Some other raw sugar factories started to produce low-quality refined sugar called crystal. That kind of sugar was a viable substitute in some segments like candy-manufacturing and wine production. In summary, the entry of outsiders into refining was the decisive additional competitive pressure for the first domestic refinery cartel that caused the temporary breakdown.<sup>33</sup>

**Second refinery cartel 1895.** On November 1<sup>st</sup>, 1895, a second cartel among refineries started to operate for the season 1895/96.<sup>34</sup> In addition to the former fixing of

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<sup>31</sup>k.k. Handelsministerium (1912, pp. 164-165)

<sup>32</sup>Hromada (1911, pp. 55-56)

<sup>33</sup>Another source—written 17 years latter—says that the drop of raw sugar prices was the decisive shock that caused the breakdown. According to that theory, raw sugar factories faced low prices for raw sugar on the world market but observed high margins in the downstream sugar refining market. Thus some raw sugar factories entered the refining market (Hromada, 1911, pp. 57-58). However, already in early 1894 when raw sugar prices were not significantly lower than the five preceding years, it was clear that entry had occurred and that the first cartel would not continue to operate during the season of 1894/95 (Neue Freie Presse, 1914, 1894/3/6;3/7;3/10;3/16;4/7;5/3).

<sup>34</sup>For this agreement I solely rely on secondary sources. The next available agreement among refineries dates from 1906. Thus some clauses in the 1906 agreement might have already been used in the 1895 agreement.



total sales for the whole year, the monthly release of sugar was now fixed by the cartel management<sup>35</sup> in order to impede the accumulation of inventories.<sup>36</sup> The second cartel operated successfully. However, the higher margin of refineries faced steady competitive pressure by entering raw sugar factories.<sup>37</sup>

**Cooperation of raw sugar factories.** Already when the first cartel ended in 1894, it was known that limiting access to raw sugar was necessary to impede entry of outsiders. First plans to form a greater cartel—including the raw sugar factories—were made public in the summer of 1894. It was important that all raw sugar factories—178 in 1897—cooperated in order to support the cartel of the refineries. In order to impede entry on the refinery market, raw sugar factories should supply only refineries within the cartel with raw sugar and thus refuse to deal with outsiders. In return, refineries should give part of their profit to the raw sugar factories.<sup>38</sup>

How can 178 raw sugar factories cooperate? The raw sugar factories acted on two markets. Due to low transport costs, all 178 existing raw sugar factories competed in exporting or selling raw sugar to the refineries. On a much more local scale, in each case a few sugar factories competed in purchasing sugar beets from beet farmers. The crisis on the world sugar market and the price drop in 1894/95 exerted significant pressure on the margins of raw sugar factories. They could not afford to pay the prices for sugar beets they had agreed on in early 1894.<sup>39</sup> Higher margins for raw sugar factories thus required restraints on competition in the purchase of beets as well as in sales of raw sugar.

In December 1896, all 178 raw sugar factories established a common cooperative. Small groups were formed that agreed on purchasing sugar beets from local farmers. Different collusive forms were exclusive purchase territories, purchasing quotas within a territory or a combination of both. The local price and purchasing conditions for sugar

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<sup>35</sup>Hromada (1911, pp. 57-58)

<sup>36</sup>Hlawitschka (1902, p. 6)

<sup>37</sup>Hromada (1911, p. 59)

<sup>38</sup>Neue Freie Presse (1894/7/20)

<sup>39</sup>Hromada (1911, p. 64)

beets were fixed with simple majority or by a leading firm. For the case of an entering outsider in local beet purchasing, the local cartel was able to approve collective predatory pricing. Disputes—often locally—were resolved by an internal arbitration panel. The cooperative had a plenary meeting, a supervisory and a management board located in Vienna. Regional representations were established in Brno, Prague and Budapest. The cartel duration was ten years, the exit notice was a year and the exit was forbidden for the first four years—except for an unaccepted change of the agreement. Members had to provide a security deposit.<sup>40</sup>

The formation of the raw sugar cooperative was central to enable centralized negotiations between the refineries' cartel and the raw sugar factories.

**First great cartel in 1897.** On July 26<sup>th</sup>, 1897, the so-called great sugar cartel—including all 178 raw sugar factories and all 58 refineries—was signed.

Trade with raw and refined sugar had to be done within the cartel. In order to limit entry into the refinery market, raw sugar factories were not allowed to produce refined sugar or to support or establish an outsider refinery. In order to limit entry into the raw sugar market, refineries had to purchase the raw sugar from member raw sugar factories and were not allowed to support or establish an outsider raw sugar factory.

Sales of refined sugar on the domestic market were limited by a quota system. The threat of entry by existing raw sugar factories on the market for refined sugar was eliminated—all raw sugar factories were additionally paid a premium to the export price for raw sugar according to their quotas.

In order to finance this premium, the refineries had to compensate for raw sugar prices below 30 K based on the raw sugar they processed and sold as refined sugar within the domestic cartel. But compensation was limited to 8 K per 100 kg raw sugar—prices below 22 K per 100 kg were absorbed by raw sugar factories. The redistribution of this compensation payment was based on historical production of raw sugar. The maximum

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<sup>40</sup>Hromada (1911, pp. 65-68)

production of the last nine years (1888/89-1896/97) served as a basis for redistribution. For Hungary, the on-going year (1897/98)—in which beets were already growing—was included, too. Smaller factories—with less than 3,500 tons production of raw sugar per year—received a quota according to their maximum production. All other factories received a pro rata quota so that total historical production eligible for compensation was limited to 1,050,000 tons of raw sugar. This central compensation clause became effective on November 1<sup>st</sup>, 1897 (w/o, 1897, p. 4), thus I date the start of the first great cartel with November 1<sup>st</sup>, 1897.

Monitoring of the raw sugar factories was based on the following rules: Contract notes that showed the sugar's origin and its destination for all trades were obligatory. All individual sales—including exports—had to be reported within ten days after each month to a joint committee. Controlling bodies had the right to inspect raw sugar factories. Raw sugar producers were liable for sales agents, too. Trades without a contract note and outside the cartel were penalized with 20 K per 100 kg (but penalties were limited to 50% of the transaction value at market prices). For raw sugar factories, exclusion was another sanction. Even late notification of information was sanctioned with up to 400 K.

Banning exit from the cartel was a central element: An immediate exit was only possible in case of a change of the excise tax or the import duty. Refineries could leave the cartel if a new refinery entered the domestic market or if an infringement surpassed 10,000 tons. However, an exit never occurred.

Decision-making and management was delegated to a joint committee consisting of three representatives of refineries and raw sugar factories. For refineries as well as raw sugar factories, the three representants came from Bohemia, Moravia and Hungary representing the main producing regions. This six person committee decided with a two-thirds-majority. Dispute resolution and the imposition of larger penalties was delegated to an arbitration panel. The panel consisted of two arbitrators chosen by the two parties and a third, jointly chosen arbitrator. Parties had a right to be heard. The panel was allowed to summon witnesses and to consult with experts. Decisions were made with

simple majority. The procedure was similar to civil law proceedings.

As to the financing of the cartel, costs were split evenly between refineries and raw sugar factories on a pro rata basis relative to the quota.<sup>41</sup> For lobbying activities, the joint committee had a right to ask for up to 0.2 K per 100 kg—about 0.5% of the net of tax sales price—without being billed. This extra money was spent for the media and other lobbying activities.<sup>42</sup>

The refinery market was still managed by the quota agreement among refineries. Additionally—from July 1897 on—the price was fixed, too. In order to ensure the minimum price, the commonly-run refinery had to buy all sugar below the respective quota at the fixed price discounted by 1,5%. A first cartel fee amounting to 1 K per 100 kg was introduced to cover various expenses of the commonly-run refinery.<sup>43</sup>

The first great cartel successfully operated until August 1903. All active raw sugar factories and refineries within Austria-Hungary adhered to the clauses of the agreement.<sup>44</sup>

**Dealing with politics and the media.** Meanwhile, the success of the first great cartel led to massive price increases and damages to consumers. Neither elastic demand nor entrants limited the cartel's pricing power which led to political opposition. Political concerns and protests in the media against the various cartels were already expressed in July 1891 in the parliament when the first refinery cartel formed. Renewed concerns led to a draft law against cartels in industries with indirect taxes in 1897/1898.<sup>45</sup> However, it was never passed by parliament. Because the monarchy was not a democracy with equal voting rights, sugar industrialists—Kraus called them “Zuckerbarone” (sugar barons)—were strongly represented in parliament (Kraus (Vol 129, 1903, pp. 4): *“In other countries members of parliament resign as a member, if their personal interests are involved. The sugar refiner Auspitz resigned as a member, since his party did not elect him into the*

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<sup>41</sup>w/o (1897)

<sup>42</sup>Hromada (1911, pp. 69-76)

<sup>43</sup>Hromada (1911, p. 58)

<sup>44</sup>Hromada (1911, p. 58)

<sup>45</sup>Hanreich (1989, pp.144-166) surveys the intentions within Austria-Hungary to legislate cartels.

*sugar committee and since he did not accept that his right for corruption was diminished.”)* Anecdotal evidence suggests that parts of the media were bribed.<sup>46</sup>

Furthermore, the government and the industry backed each other. For example, the cartel limited the release of sugar before the second large tax increase in August 1899 in order to limit demand anticipation.<sup>47</sup> In August 1897—when prices rose due to the advent of the first great cartel—the imports of the substitute saccharin started to threaten sales of sugar as well as sugar tax revenues.<sup>48</sup> In 1898, imports of saccharin were prohibited.<sup>49</sup> The industry even asked—but without success—for a higher protective duty when the world market prices dropped in 1902 and some minor imports occurred.<sup>50</sup>

**Collusion with a foreseeable end.** The year before the Brussels Convention came into force, a renewed agreement was formed until October 31<sup>st</sup> 1903. Prepurchase and presales were again forbidden before September 1<sup>st</sup>, 1903—when the convention came into force.<sup>51</sup> The refinery cartel faced the risk that firms would leave the cartel in order to gain an outsider profit for the last months before the protective duties would be lifted. This corresponds to economic theory that suggests that a game with finite repetitions may only have a non-collusive equilibrium.<sup>52</sup>

On March 20<sup>th</sup>, 1903—before the Brussels Convention came into force—the cartel formed an exclusive joint sales company located at the commonly-run refinery in Chropyně.<sup>53</sup> Refineries were allowed to sell up to 3% of their quota in the local surroundings at centrally fixed prices. A committee consisting of 13 refineries was in charge of the joint sales company and fixed the price and freight for each place within the monarchy. Price differences for different grades of refined sugar were fixed, too. Deliveries and invoicing was done by the individual refineries based on a central contract note. The individual

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<sup>46</sup>Hlawitschka (1902, p. 76-81)

<sup>47</sup>Kraus (Vol. 13, 1899, pp. 1-4)

<sup>48</sup>Neue Freie Presse (1897/08/28)

<sup>49</sup>See Roth and Lück (2011).

<sup>50</sup>Hlawitschka (1902, p. 35)

<sup>51</sup>Hromada (1911, pp. 76-80)

<sup>52</sup>See, for instance, Ivaldi et al. (2003).

<sup>53</sup>Hromada (1911, p. 60)

refineries conferred treaties with sales agents to the joint sales company. Orders, contract notes and bills had to be immediately reported to the joint sales company. On a weekly basis, freight costs, internal consumption, sugar donations, and a register of outstanding bills had to be reported.<sup>54</sup>

Thus the refinery cartel centralized sales in an exclusive joint sales company to cope with the expected break-down of the cartel in the near future.

### 3.4 The Cartel after the Brussels Convention

**Break-down in September 1903.** On September 1<sup>st</sup>, 1903, the first great cartel broke down due to the Brussel Convention. This multilateral trade agreement banned export bounties and limited import duties to 5.7 K. The agreement between refineries and raw sugar factories included a sunset clause for such an event—the first great cartel was dissolved.

**State-run cartel incompatible with Brussels Convention.** The industry and the government tried to maintain the industry organization via a law similar to the preceding cartel agreement. The ministry of finance headed by the Austrian economist Eugen von Boehm-Bawerk proposed the draft law. In the bill, output of raw sugar factories as well as refineries was regulated by a quota. Refineries had to make a compensation payment to the raw sugar factories amounting to 3.5 K per 100 kg. Despite heavy opposition—the redistribution from consumers to the industry was obvious—parliament approved the law.<sup>55</sup> But the law never took effect: The Brussels Convention had a permanent commission in Brussels to monitor the convention. The law was declared incompatible with the Brussels Convention on June 20<sup>th</sup>, 1903, since the regulated cartel was an indirect export bounty.<sup>56</sup> Thus the emperor had to withdraw the law and cartelization was not maintained. Finally, a duty within the dual monarchy was intro-

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<sup>54</sup>Kartell-Rundschau (1903, pp. 318-321)

<sup>55</sup>For a detailed documentation on the literally fightings on the law in parliament, see Arbeiterzeitung (1903/01/31).

<sup>56</sup>Hromada (1911, p.142) and Walker (1903).

duced to at least be able to separate the Hungarian and the Austrian market. Sugar imports to Hungary surpassing a certain amount were charged a duty of 3.5 K in order to protect the Hungarian industry. Already in July 1903, the industry started to lobby for discriminatory freight rates that favored exports and impeded imports.<sup>57</sup>

**Dissolution of the joint sales company in August 1904.** The Brussels Convention did not prohibit private cartels. Thus, the majority of refineries tried to maintain the cartel among refineries, but due to some outsiders the joint sales company was finally dissolved in August 1904.<sup>58</sup> Due to these outsiders, prices for refined sugar returned to export parity and thus soon the competitive level. For some years, the sugar industry faced competition on the new domestic market. Plans to cartelize could not be implemented within the next three years.

**Third refinery cartel 1906-1911.** On September 24<sup>th</sup>, 1906, refineries signed the next agreement that became effective on October 1<sup>st</sup>, 1906. It solely included refineries within the Austrian part of the monarchy. Within Hungary, a separate agreement had been formed—the two cartels agreed to refrain from competing with each other. Austrian sales to Hungary were limited to 25,000 tons.<sup>59</sup> The third refinery cartel fixed quotas for refined sugar. However, sales of raw sugar and crystal sugar were not included in the agreement.<sup>60</sup> In 1906, an offer to form a privately organized great cartel in the spirit of the 1903 law was not successful.<sup>61</sup>

The measurement of the quotas was done with respect to the payment of the tax. Refineries were able to postpone the payment of taxes by selling to tax free warehouses, which had to pay the taxes not until they sold the sugar to the customers. The agreement made refineries liable for the sales of their sugar when the tax was paid—thus also for sales from the free warehouses. Quotas were allocated to individual refineries for specific

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<sup>57</sup>See Centralverein (1904, pp. 119)

<sup>58</sup>Centralverein (1905, p. 128)

<sup>59</sup>Hromada (1911, p. 139)

<sup>60</sup>k.k. Handelsministerium (1912, p. 115)

<sup>61</sup>Prager Zuckermarkt (1906, 1906/10/16)

periods.<sup>62</sup> I stress this point since it allowed a stricter control of the monthly release of sugar. Sales outside the contract were penalized with 10 K per 100 kg. The committee recommended a margin and thus the retail price at least on a monthly basis. Entry of outsiders required approval by all members. In order to prevent imports or expansion of producers of crystal sugar, the third cartel started to offer retroactive exclusivity rebates: Customers with exclusive purchases at the cartel above 60 or 240 tons a year got a refund paid out by a central office of 0.25 or 0.5 K per 100 kg. In order to monitor each customer the refineries had to report individual sales to this central office. The duty to report included name and residence of the customer, date of the contract and delivery, type of sugar, price and freight for sales delivered by the seller. So the office was able to keep individual accounts for all sales to each customer. A contract note was recommended.<sup>63</sup>

In 1909, the 1906 agreement was renewed. Some adaptations were made in order to improve the prevention of entry and expansion of outsiders as well as the export restriction to Hungary: The contract note was made obligatory for sales above one ton. The exclusivity rebate was restricted to 240 tons. The contract note also included the clause that breaches of the exclusivity clause were penalized with 1 K per 100 kg and that sales to Hungary or Bosnia were penalized with 5 K per 100 kg. In order to avoid an abuse of the exclusivity rebate and a circumvention of the regional restriction, even resellers—the second hand—had to use the contract note. These resellers were obliged to push the claim against another reseller—the third hand—or assign it to the selling refinery. All refineries within the third cartel were liable for the rebates.<sup>64</sup>

**Renewed negotiations with raw sugar factories.** Meanwhile, raw sugar factories supplied crystal sugar that was of lower quality. From 1908 on, crystal sugar was listed and traded at the Vienna product exchange.<sup>65</sup> This indicates that the importance

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<sup>62</sup>It cannot be excluded that the refineries' agreement in 1895 already included such a clause.

<sup>63</sup>k.k. Handelsministerium (1912, pp. 114-120)

<sup>64</sup>k.k. Handelsministerium (1912, pp. 125-127)

<sup>65</sup>Neue Freie Presse (1908/12/15)



of crystal sugar rose.<sup>66</sup> Another relevant factor for the formation of the second great cartel was the stronger organization of sugar beet farmers. Farmers started to organize themselves in order to improve their bargaining power in the negotiations with raw sugar factories. They established a cooperative and rented a raw sugar factory to process the sugar beets on their own.<sup>67</sup> In 1909 there was a new draft for a great cartel; a somehow similar draft was sent to the raw sugar factories on March 18<sup>th</sup>, 1911.<sup>68</sup>

In the negotiations for a joint, great cartel, the central parameter was the price for raw sugar relative to the price for refined sugar since it distributed the cartel profit between refineries and raw sugar producers.<sup>69</sup> Some smaller refineries—each of them had less than half the average quota and presumably higher marginal cost—asked for a higher profit. On the other hand, 17 raw sugar factories in Bohemia with well-respected owners unanimously agreed to build a commonly-run large sugar refinery next to a streamway.<sup>70</sup>

**Second great cartel.** On April 29<sup>th</sup> 1911, a second great cartel was formed. Refineries had to pay additional 3.5 K per 100 kg of sold refined sugar—exactly the same amount as in the 1903 draft law—to a common fund that was payed out to the raw sugar factories. The payment was obligatory for all sales realized after September 30<sup>th</sup>, 1911,<sup>71</sup> thus I set October 1<sup>st</sup>, 1911, as the effective beginning of the second great cartel. The main rules were the same as for the first great cartel: Vertical integration was forbidden for refineries as well as for raw sugar factories. Trade of raw sugar had to be made exclusively within the cartel based on contract notes, deviations were penalized with 10 K per 100 kg. The information exchange and auditing duties for raw sugar factories were similar to the refineries' system. The decision-making was delegated to a joint committee with eight members, a two-thirds majority was necessary for decisions. An arbitration

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<sup>66</sup>Unfortunately, sugar tax data do not distinguish between crystal and refined sugar.

<sup>67</sup>Hromada (1911, pp. 146-171)

<sup>68</sup>Kartell-Rundschau (1911, pp. 322-324)

<sup>69</sup>In Hungary, the existing refinery cartel after the Brussels convention was renewed. A second great cartel like in Austria was not realized (Kartell-Rundschau (1911, p. 819)). There was another renewal for five years (Kartell-Rundschau (1912, p. 939)).

<sup>70</sup>Kartell-Rundschau (1911, pp. 242-245)

<sup>71</sup>k.k. Handelsministerium (1912, p. 136)

panel was responsible for dispute resolution.<sup>72</sup> The second great cartel was still active when World War I broke out in late July 1914.

### 3.5 Review of Agreed Cartel Rules

Table 1: Agreed Rules on Sales of Consumable Sugar

Period				Sales of Refined Sugar			Sales of Crystal Sugar		
Start	End			Ann.	Mon.	Forw.	Ann.	Mon.	Forw.
Aug	1888	Sep	1891			ban			
Oct	1891	Sep	1894	quota		ban			
Oct	1894	Oct	1895						
Nov	1895	Sep	1897	quota	quota	ban			
Oct	1897	Aug	1903	quota	quota	ban	quota	quota	ban
Sep	1903	Aug	1904	joints.	joints.				
Sep	1904	Sep	1906			listed			
Oct	1906	Sep	1908	quota	quota	ban			
Oct	1908	Sep	1911	quota	quota	ban			listed
Oct	1911	Jul	1914	quota	quota	ban	quota	quota	listed

Notes: Ann. = annual, Mon. = monthly, Forw. = forward contracts, joints. = joint sales agency, listed = futures can be observed.

Table 1 lists the observed agreed rules for the sales of refined and crystal sugar and whether annual sales, monthly sales or forward contracts were regulated by the industry. For some time periods information is not available whether forward contracts existed. Therefore, I have entered “listed” in Table 1 to indicate the periods when I observe futures—forward contracts traded at the product exchange.<sup>73</sup>

<sup>72</sup>k.k. Handelsministerium (1912, pp. 132-145)

<sup>73</sup>In order to gather this information, I collected the published prices of the Vienna Exchange on 15<sup>th</sup> December for the years 1887 to 1913 in the newspaper Neue Freie Presse. I classify all prices that include delivery beyond the current month as future. There was always a future for Pilé sugar with delivery in Trieste. For raw sugar, there was always a future for delivery in Ústí nad Labem—with the exception of 1894, when raw sugar was abundant and raw sugar prices hit a low never seen before. Table 1 includes the periods when futures for refined or crystal sugar were listed at the Vienna exchange.

## 4 Data

In order to empirically describe and evaluate the effects of the sugar cartel, I describe the available data and the data generating process in this section. First, I present data on prices and various opportunity cost factors. Second, I describe the tax statistics as a source for aggregated sales data. I apply a decomposition procedure to estimate trend consumption, seasonal and anticipating net-inventorying. Third, I present some macroeconomic variables.

### 4.1 Price and Cost Data

Sugar in different kinds was traded and listed at the stock exchange in Vienna and Prague. Trade practices defined the standards for the traded products. For example, all kinds of refined sugar had to fulfil a minimum level of purity.<sup>74</sup> I use monthly averages of the daily prices at the exchange in Vienna that were published in the weekly journal of the central association of the sugar industry (“Wochenschrift des Centralvereins für die Rübenzuckerindustrie Österreichs und Ungarns”).

For the domestic price level I use the spot market price for Viennese refined sugar, prime, delivered in Vienna (“W. Raffinade, Prima, prompt ab Wien”). “Prime” refined sugar was the first product during the repeated refining process. This product had the highest purity and thus quality. It was sold in the form of sugar loaves and packaged in barrels. Packaging of up to 3.5% of the total weight was included in the price. The price in Vienna included the domestic excise tax. For the foreign price level, I use the spot market price for Pilé Centrifugal, prime, delivered in Trieste (“Pilés Centrifugal, Prima, prompt, ab Triest”). Trieste was the main export harbor of Austria-Hungary and the main export trading place for refined sugar. The quality of Pilé differed from refined sugar in the following aspects that were documented. First, Pilé was sold in broken pieces and the content of powdered sugar was limited for Pilé in Trieste to the maximum of 20%,

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<sup>74</sup>Centralverein (1889, Addendum to Nr. 50)

whereas for refined in Vienna the upper bound is 10%. Second, Pilé was sold in bags. Third, packaging was included only up to 1,5% of total weight. Fourth, the seller in Trieste had to pay for the customs handling but he received the export bounty. In sum, there were only minor differences with respect to the documented product characteristics. Due to the lack of information, it cannot be excluded that there were other differences in product characteristics than mentioned above. Sugar was sold in many different varieties—like for instance as loaves, pieces or cubes. Since most of the refineries produced for the domestic and the foreign market at the same time, it is justified to assume flexibility of production and to estimate a constant in a regression to control for any remaining unobserved product characteristics. Finally, loaves in Vienna could easily be broken to pieces, packaging could be changed and the sugar could be exported via Trieste.<sup>75</sup> The price that was received in Trieste was thus an opportunity cost of not selling in Vienna.

There is only fragmented evidence on costs of transportation available. In 1890, for example, the transport from stations in Moravia or Bohemia to Trieste amounted to 3.7 K per 100 kg in 1890 and to 1.12-1.64 K per 100 kg to Vienna if at least 10 tons were transported. Thus, the additional opportunity freight cost was 2.04-2.58 K per 100 kg for exporting via Trieste instead of selling in Vienna.<sup>76</sup> The railway company (Suedbahn) reported during some subsidy negotiations that it received on average 1.31 K per 100 kg in 1903 for the transport relation Vienna to Trieste.<sup>77</sup>

#### 4.1.1 Descriptive Analysis of Prices

Figure 3 gives information on the prices observed.

To understand the factors that influence the domestic price, it is essential to know the alternative—exports. Trieste served as export harbor for the monarchy. Sugar was sold mainly during the last quarter of the year. The destination countries were mainly situated in the Mediterranean Area. India was the largest buyer in the East. Small

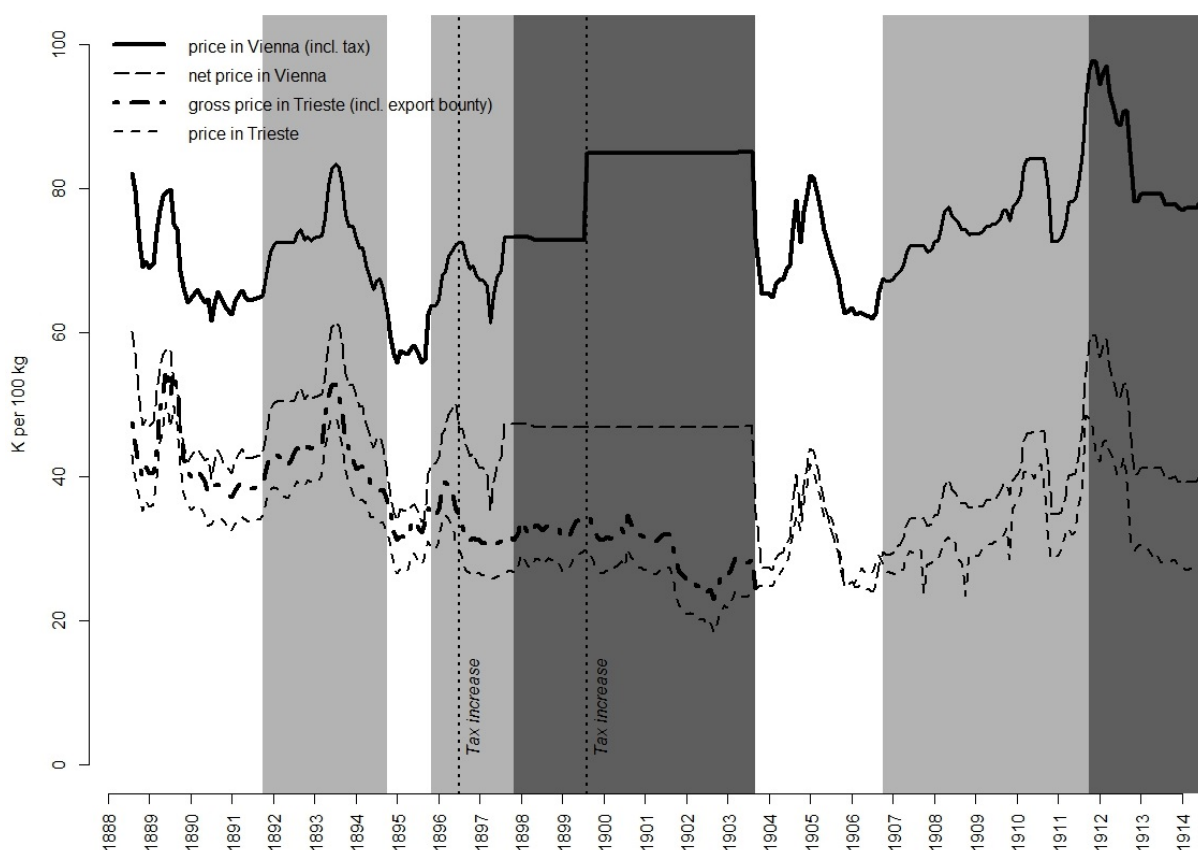
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<sup>75</sup>See also Handels- und Gewerbekammer Prag (1896, p. 82) that states that most of the refineries produced for the domestic and the export market as well.

<sup>76</sup>Centralverein (1890, p. 81)

<sup>77</sup>Neue Freie Presse (1903/08/11)

Figure 3: Prices in Vienna and Trieste, Tax and Export Bounty



Notes: The light gray areas cover the first, second and third cartel solely among refineries. The dark gray areas cover the first and the second great cartel. See also Table 1 and the preceding description for a detailed reference on the different cartels. Vertical dotted lines indicate tax increases. Prices are taken from the Vienna product exchange: (1) price for Pilé Centrifugal, prime, delivered in Trieste, (2) including the export bounty, (3) net price for Viennese refined sugar, prime, delivered in Vienna (4) gross price in Vienna (including tax).

amounts were exported to far-distant countries like Japan or Argentina. Market reports estimated yields in European beet sugar markets, worldwide inventories and analyzed the actions of England, France, India, Russia, Cuba and North-America on the world sugar market. Foreign prices for sugar were published in the weekly journal for Magdeburg, Hamburg, Amsterdam, Paris, London and New York. Data on quantities were published for the main production and consumption countries around the world.<sup>78</sup> Prices in Trieste moved in parallel with prices for raw or refined sugar in Hamburg or the price for raw sugar in Ústí nad Labem.<sup>79</sup> Thus the price in Trieste was determined by the world

<sup>78</sup>Centralverein (1914).

<sup>79</sup>Exports crossed the border to Germany at this town next to the river Elbe at the northern border

market. Additionally, the situation on the shipping markets especially influenced the prices in Trieste. A central question for exogeneity of prices in Trieste is: Did domestic demand affect the world market and thus the price in Trieste? As Table 2 shows, domestic demand for refined sugar in Austria-Hungary only accounted for an insignificant part of the world market for refined sugar. Thus, changes in domestic demand did not affect the farming decisions. Domestic demand was an inframarginal source of demand for domestic refineries and thus an inframarginal source of derived demand for raw sugar factories and beet farmers. Therefore, prices in Trieste can be interpreted as exogenous to domestic demand.

Table 2: Share of Austria-Hungary in World Production of Refined Sugar

in tons/in %	1889-1899	1899-1904	1904-1909	1909-1914
World Production	8,774,232	13,687,100	16,780,595	20,609,647
Domestic Production	643,906	937,153	1,054,819	1,209,551
Share Dom. Prod.	7.3%	6.8%	6.2%	5.9%
Domestic Consumption	300,774	360,917	469,267	559,937
Share Dom. Cons.	3.4%	2.6%	2.8%	2.7%

Source: National Bank of Commerce in New York(1917) and sugar tax statistics.

The price in Trieste in Figure 3 shows a slight seasonal pattern. On average, prices hit a low during the main refining and exporting season in November to January. The price in Trieste on average peaks around August or September. This seasonal pattern can be explained by at least two factors: First, the price in September includes the physical storage cost. Second, the price in September also includes the risk of low or high prices for sugar in the new season. Thus not only the mean but also the range of prices for September is the highest.

The pricing of sugar in Trieste is in line with the literature on storage and commodity markets. Williams and Wright (1991, pp. 157) stress two common empirical features for commodity markets. First, price series show considerable autocorrelation,  
of the empire.

thus high as well as low prices tend to continue. Second, there are spikes, thus years where prices abruptly jump to a very high-level compared to the long-run average price. Next, Pindyck (2001) discusses that competitive equilibria in storage markets differ from standard markets: Aggregate storage cannot be negative, thus borrowing from the future is impossible. Uncertainty about the future affects the storage decision, thus storage decisions are based on rational, forward-looking expectations. The distribution of prices under storage is skewed. Increases in prices are larger than typical price decreases. The variance of price changes depends on the spot price: A low spot price is associated with a high stockpile and thus the buffer is high and the variance is low; a high spot price is associated with a low or empty stockpile, and thus there is no buffer for price changes. Thus storage causes heteroskedasticity of time series for prices of commodities. Coming back to the sugar market, sugar prices in Trieste tend to stay on a given level for a while, but for some periods in some months in 1889, 1894, 1896, 1905, 1910 and 1911 prices rose abruptly. Even if the causal reasons for these price changes are unclear the sugar price pattern does not conflict with an expected price pattern of commodity goods.

## 4.2 Quantities

The change of the tax regime to an excise tax on August 1<sup>st</sup>, 1888, was a major success for the tax authorities and of major importance to the industry. First, tax evasion and avoidance immediately disappeared. Second, the ministry of finance strictly monitored the sales of the individual raw sugar factories and refineries. The aggregate tax statistics were published every 10<sup>th</sup> day in a month for the preceding month by the ministry of finance.<sup>80</sup> Thus, the tax bill and the aggregate tax statistics were available for the monitoring of individual sales on the domestic market within the cartel. Furthermore—central for the analysis of this paper—an exact measure of sales of consumable sugar on the domestic market became available as well.

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<sup>80</sup>Even output data for almost all individual refineries and raw sugar factories was published on an annual basis for several years.

It is crucial to understand what the official statistics for sales of refined sugar exactly measure. Sugar was superposable, thus sugar factories, refineries, tax-free warehouses, wholesalers, downstream manufacturers, retailers as well as final consumers were able to store sugar. Sugar was taxed at the gate of the factory, the refinery or the tax-free warehouse. Official statistics thus published the flow of refined sugar out of the refinery or tax-free warehouse.<sup>81</sup> Thus the actual amount of consumption is not directly observable since sales measured at the point of taxation consist of the actual consumption as well as the net flow into the taxed stocks of wholesalers, downstream manufacturers, retailers and final consumers.

#### 4.2.1 Decomposition of Sales

In order to provide a first univariate descriptive analysis into these effects, I apply a structural time series decomposition procedure initially presented by Cleveland et al. (1990). This procedure allows a decomposition of the sales  $Q_t$  series into a trend component  $T_t$ , a seasonal component  $S_t$  and a remainder component  $R_t$ .

$$Q_t = T_t + S_t + R_t \tag{1}$$

I choose this procedure due to the relatively flexible modeling of changes in the seasonal pattern and due to the robustness against outliers. Central for smoothing the time series are locally weighted regressions for each individual data point. The weights are based on the distance to the estimated data point. The procedure consists of two loops. The inner loop detrends the series in the first step. The second step smooths the 12 monthly cycle subseries individually. The third step applies a filter to each data point received by the 12 monthly subseries for the length of the period. The fourth step creates the seasonal component. It detrends the 12 monthly cycle subseries received in the second step by the filter received in the third step. In the fifth step, the original series is deseasonalized

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<sup>81</sup>Furthermore, the monthly production of refined sugar, the untaxed stocks of refineries and warehouses, the amount of exports as well as imports was published.

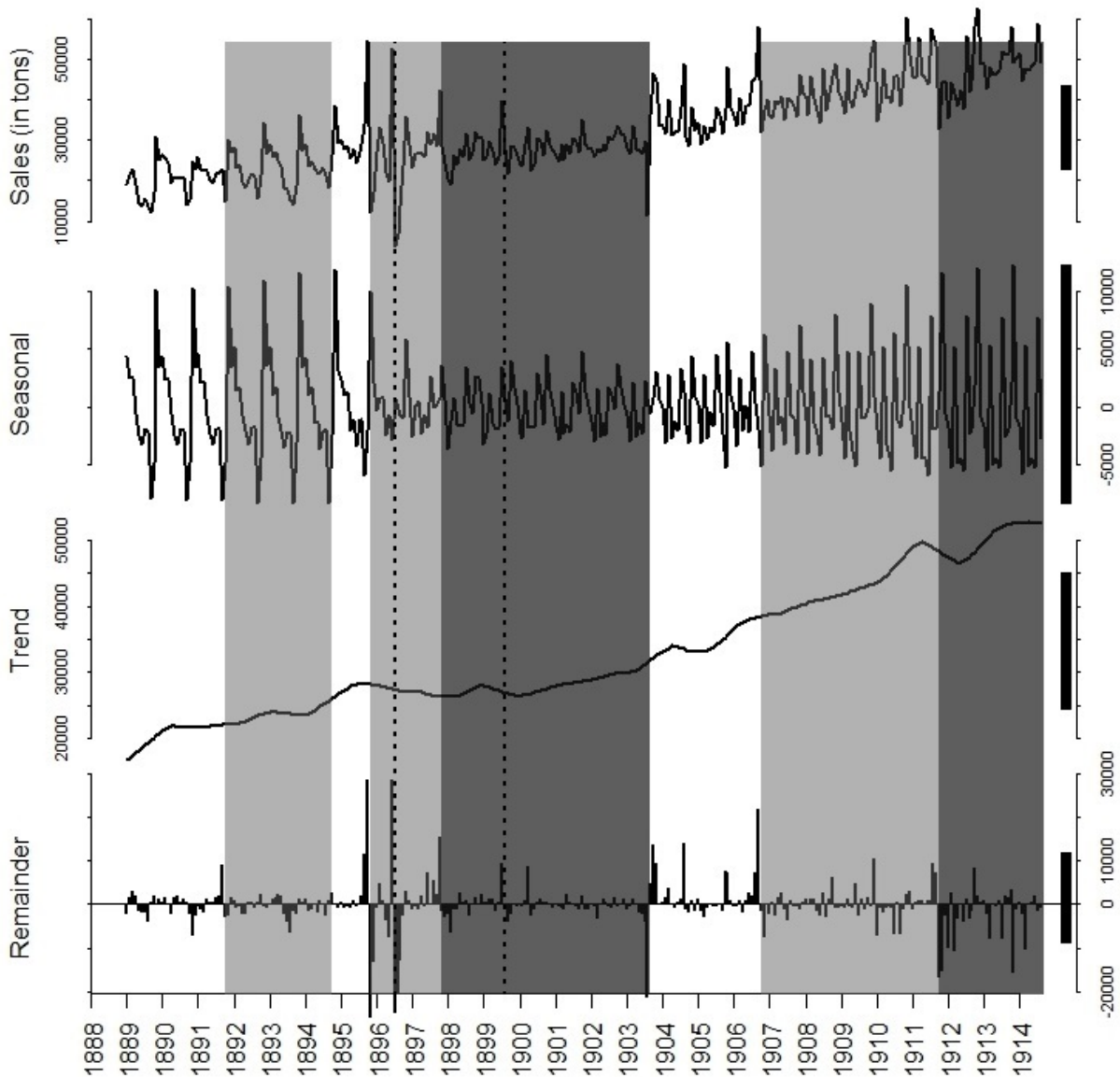


by the seasonal component in step four. In the sixth step, the deseasonalized series is detrended once more to decompose the series further into a trend and a remainder series. The outer loop is used only for robust analysis and weighs the data points according to the extremeness of the remainder. For the application, several parameters have to be specified. Some parameters are chosen by the procedure. What I had to choose is the number of included observations for seasonal smoothing in step two and whether I would use the outer loop for a robust estimation. Based on the changing and thus evolving seasonal pattern due to different cartel behavior I chose the minimal length of seven data points for the monthly cycle subseries that is not affected by the demand anticipation before tax or cartel changes. Thus three data points in the monthly subseries before and after the estimated data point are the input for the locally weighted regressions. I also had to choose the robust estimation method. The demand anticipation effects—net inventorying—is decomposed into the remainder, the robust estimation gives these data points a lower weight. The procedure automatically chooses how many observations are used for the trend. The parameter is 23, thus 11 future months are also used for the trend. This leads to an estimated trend that anticipates the actual sales data.

Figure 4 shows the resulting decomposition. Trend monthly sales (a proxy for consumption) increase from slightly above 20,000 tons around 1890 to more than 50,000 tons just before 1914. This indicates a trend of increasing use of sugar. A strong seasonal sales pattern is observed until the second refineries' cartel starts in November 1895. Seasonal variation is diminished for the phase of the first great cartel until August 1903. Then a stronger seasonal pattern in absolute terms slowly reemerges—however, relative to the trend sales, the seasonal pattern is much lower than before 1895.

The remainder indicates positive demand anticipation effects before a cartel phase starts or the tax is increased—lower sales in the subsequent months are visible, too. Table 3 gives an overview over the largest remainders that are associated with events. The strongest estimated effects—roughly 30,000 tons sales that are not attributed to the trend or the seasonal pattern—are observed at the regime switch from competition to the

Figure 4: Decomposition of Sales into Seasonal, Trend and Remainder



Notes: (1) Actual sales are drawn in the first plot and decomposed in a seasonal, trend and and remainder component in plots 2-4. The scales of the four plots are different. The size of the black box next to the right axis is proportional to the scale of the respective axis. (2) The light gray areas cover the first, second and third cartel solely among refineries. The dark gray areas cover the first and the second great cartel. See also Table 1 and the preceding description for a detailed reference on the different cartels. Vertical dotted lines indicate tax increases.

refineries' cartel that fixed also the monthly release in October 1895 and before the first tax increase by 4 K on July 1<sup>st</sup>, 1896. For the second tax increase (by 12 K) on August 1<sup>st</sup>, 1899, the government and the cartel agreed to limit demand anticipation.<sup>82</sup> The start of the third refineries' cartel in 1906 was public knowledge only one week in advance.

<sup>82</sup>Kraus (Vol. 13,1899, pp. 1-4)

Table 3: Estimated Net-Inventorying for Cartel/Tax Events (in tons)

Date	Cartel/Tax Event	Preceding Month		Subsequent Month		
		2	1	1	2	3
Oct 1 <sup>st</sup> , 1891	Start 1 <sup>st</sup> Cartel		8,987			
Nov 1 <sup>st</sup> , 1895	Start 2 <sup>nd</sup> Cartel	11,533	28,700	-25,893	-13,082	
Jul 1 <sup>st</sup> , 1896	Tax Increase		28,367	-24,600	-20,442	-12,786
Nov 1 <sup>st</sup> , 1897	Start 1 <sup>st</sup> Great Cartel		15,546			
Aug 1 <sup>st</sup> , 1899	Tax Increase		9,397			
Aug 31 <sup>st</sup> , 1903	End 1 <sup>st</sup> Great Cartel		-20,994	4,879	13,656	9,289
Oct 1 <sup>st</sup> , 1906	Start 3 <sup>rd</sup> Cartel	7,125	21,884	-1,171	-7,146	
Oct 1 <sup>st</sup> , 1911	Start 2 <sup>nd</sup> Great Cartel	9,254	7,133	-16,544	-15,279	

Notes: The effects are estimated from the decomposition shown in Figure 4. Effects larger than 5,000 tons for two preceding and three subsequent months were selected. Effects within these selected events are also included.

Still, the estimated net-inventorying indicates that insiders started to sell sugar already a month ahead. Some outliers are not related to specific events in Table 3 but visible in Figure 4. One peak of the remainder in August 1904—more than 10,000 tons remaining sales—coincides with the dissolution of the joint sales company. In November 1913, the remaining component is -15,100 tons whereas the seasonal component is +12,200 tons. This indicates that for the last years, the decomposition procedure runs into problems due to the cut-off in August 1914.

To sum up, the sales data based on the tax deviate from consumption due to two different effects. First, any change in the competitive regime or in the tax leads to demand anticipation. Second, the intraannual sales pattern varies. A look on the sales time series reveals that the time series is non-stationary. A formal unit root test reveals that the log of sales—that are used for demand estimation later on—are trend-stationary.

### 4.3 Macroeconomic Variables

Basic macroeconomic variables like the price level, the growth of income or population are commonly used to calculate real prices and explain shifts in demand. For Austria-

Hungary before 1914, the availability of such additional explanatory variables is very limited. The price level in Vienna, the gross domestic product and the total population are available only on a yearly level.<sup>83</sup> The population in Austria-Hungary grew on average by 0.9% between 1888 and 1913, real economic growth was on average 2.0%. Recessions with negative growth occurred in 1889, 1897 and 1904. From 1888 to 1903, the price level remained constant while for some single years, even deflation is observed. From 1902 to 1913, a cumulated inflation of 30% is observed.

## 5 Demand Estimation

In this section, I present estimates for the demand elasticity and the choices and assumptions I made.

### 5.1 Instruments

The first issue to consider is endogeneity. The common approach to deal with endogeneity is the estimation of a structural model or at least a reduced form. Figure 3 makes clear that the price in Trieste  $P_T$ , the export bounty  $b$ , the excise tax  $t$ , and the competitive behavior vary within the observed period. Thus they are relevant instruments. The export bounty, the tax and transport costs are not affected by the variation in domestic demand. Thus these variables are valid exogenous instruments. The price in Trieste reflects the world market—see Table 2 and the preceding paragraph. It is justified to assume that domestic inframarginal demand did not cause prices in Trieste to change. As to the competitive behavior, the mark-up over opportunity cost is by standard definition of profit-maximization influenced by the elasticity of demand. However, the time periods for cartelization are not influenced by domestic demand for refined sugar. The break-downs were results of entry due to the high margins and the duty induced lowered cartel gain during the period 1903-1906. The changes to the first and second great cartel in 1897 and

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<sup>83</sup>GDP and population are taken from Schulze (2000), the price index for Vienna is taken from Mühlpeck et al. (1979, pp. 678-679).

1911 are a result of longstanding negotiations between raw sugar factories and refineries. The time periods are thus not affected by domestic demand. Due to this exogeneity, I use the dummies as additional instruments. To sum up, I use the opportunity costs—the price in Trieste, the export bounty and the tax—as well as the cartelization periods as instruments.

## 5.2 Frequency

As to the frequency of the data, I have the luxury of available monthly sugar tax data. Figure 4 and the analysis above show that stock-piling due to demand anticipation and changes on the seasonal release of sugar do strongly affect sales data. Thus I first review some relevant literature.

**Short review on relevant literature on demand anticipation** In a similar paper on the static oligopoly conduct in US sugar industry, Genesove and Mullin (1998) aggregate their monthly data to quarterly data. They justify the loss of degrees of freedom by pointing to the danger to estimate a misleadingly low elasticity due to grocer or consumer switching costs. A forward-looking monopolist would abstain from using the short-run demand elasticity to set the profit-maximizing price. They do not explicitly model the dynamic behavior of market participants but do a simple sensitivity analysis by repeating their estimation with monthly data that confirms their result for the quarterly model. Hendel and Nevo (2004) provide a short survey on consumer stock-piling. For storeable products like cars or food bought in the supermarket, the consumer is able to time the purchase and thus exploit price fluctuations. Price reductions usually lead to an increase of quantities. However, as in my case with sugar in the 19<sup>th</sup> century, it is not trivial to split the short-run reaction of demand into a consumption and a stock-piling effect. Consumption and inventories are unobservable. Contrary to the fear of Genesove and Mullin (1998), short run price elasticities are more likely to overstate the long run response to a price change since they capture the consumption and the stock-piling effects. Hendel

and Nevo (2006) analyze the sales of product-differentiated laundry detergents based on weekly scanner data. They model the underlying unobserved inventory and the prices for all products in the relevant period. Thus they get an optimal consumption path—without stock-piling. Static demand overestimates the own-price elasticity by 30%. In the conclusions, they state that it is still an open question how the results using static estimation with less frequent data compare to their dynamic results. Hendel and Nevo (2010) do another study on demand anticipation with Coke and Pepsi. They assume a limited time period for storage and develop a model to account for dynamic demand. Although it is not the main aim of their paper, they compare their model with alternative approaches that are relevant for my analysis, too: First, they use a sub-sample where their model predicts no storage. Second they aggregate their weekly data to a monthly frequency. For both approaches, the own-price elasticity is significantly lowered and approaches to the level estimated in their dynamic model.<sup>84</sup>

Summarizing the literature review, aggregation of the time periods and thus changing the frequency or estimating the elasticity only for periods without stock-piling effects are reasonable approaches. Planned price decreases by individual firms are the source for stock-piling in these studies. This differs from my analysis: I observe stock-piling due to an expected increase in prices in the future. Sales start to react when the future price change becomes public knowledge. Since there is no information available on the effective date, I cannot incorporate that into my estimation.

### **5.2.1 Choosing the relevant Periods for yearly Aggregations**

Demand anticipating the introduction of the excise tax led to increased stocks in 1888. Thus, tax statistics on sales from August 1888 to December 1888 are biased downwards and do not correspond to the typical pattern. Therefore I start my period of analysis in January 1889. The collected tax statistics end in August 1914. In order to identify the best periods for aggregation I considered several criteria. First, minimizing seasonal

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<sup>84</sup>Aggregation works fine for the own-price elasticity. But it causes significant problems for the cross-price elasticity between Coke and Pepsi.

storage requires choosing the season according to the typical inventory cycle. Inventories reach their low on September 30<sup>th</sup>, thus the yearly inventory cycle runs from October to September. Statistically, this corresponds also with maximizing the variance of the explanatory variable—the price in Vienna. Since I neglect the demand anticipation effect, this choice risks a high negative autocorrelation of sales. Second, minimizing demand anticipation effects requires choosing the yearly periods as far away from anticipated events as possible. All the events—tax increase or cartel starts, ends, or changes—took place either on the first of July, August, September, October or November. This corresponds to smoothing the price and thus minimizing the variance of this explanatory variable. Therefore the optimal period is from February to January. For aggregation in general, I aggregate calculated monthly revenues and monthly sales. Prices are calculated by division of those aggregates in order to receive a sales weighted average price. I also aggregated the data to quarterly and semiannual periods. The results are within the range of the yearly and monthly data. Thus I do not report these models here.

### 5.2.2 Choosing the Periods without Stock-piling

The second approach recommended in the literature is using only data without stock-piling for the estimation of the elasticity. I looked for dates with changes of the cartel (see Table 1) or the tax. Then I took the six preceding and the six subsequent months—I removed 116 months from the data set.<sup>85</sup>

## 5.3 Estimation Results

I do my estimation in logs.<sup>86</sup> All nominal variables are deflated by the price index for Vienna. A simple trend turned out to be superior as a demand shifter, thus I neglect all

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<sup>85</sup>For the dissolution of the Joint Sales Company in August 1904, I only removed three months before and after August 1904.

<sup>86</sup>Different functional forms did not lead to different results.

other macroeconomic variables and estimate the following equation:

$$\log Q = \log P_V + Trend + u \quad (2)$$

For the estimation with instruments, the first stage estimation regresses the real price in Vienna on the real opportunity cost (the price in Trieste, the tax, the export bounty) as well as five dummies for the different cartel periods. The estimation is also done in logarithms. The results are displayed in Table 7 in the appendix.

For the three models without missing values, I made some tests regarding the instruments. For all three models, weak instruments are rejected. Furthermore, a Wu-Hausmann test does not reject the exogeneity of the price in Vienna. Thus, I reestimate all the models without an instrumental variable estimator.

For all models, there is a trend growth of 3.5 to 3.6%. The central estimate for the elasticity varies between -0.40 and -0.60. The yearly aggregation that does not smooth demand anticipation events shows a relatively high elasticity of -0.55, whereas the aggregation that smoothes the storage pattern as far as possible leads to a lower elasticity. For the latter, the Durbin-Watson test does not reject a lack of autocorrelation. Including the months with net-inventorying different from zero leads to a slightly higher elasticity of -0.60 compared to -0.46 or -0.49. For all specifications, the elasticity significantly differs from one. Thus demand is inelastic. Although yearly aggregation reduces the sample size to 25 or 24 observations, the standard error of the elasticity is the lowest. The results without instruments in the lower part of Table 4 are not significantly different than the results with instruments. Thus I do not further comment on them.

Inelastic demand for refined sugar seems to contradict Genesove and Mullin (1998) that report unit elastic (for the high season in summer) or elastic demand for refined sugar cane sugar. Several issues might explain these differences. First, beet sugar was a substitute in the US, whereas all sugar sales in Austria-Hungary were part of the cartel. The share of beet sugar in the US grew from less than 1% in 1894 to 15% in 1914. Second,



Table 4: Estimation of Demand Elasticity

	with instruments				
	(1)	(2)	(3)	(4)	(5)
Constant	16.462*** (0.281)	17.178*** (0.365)	14.296*** (0.514)	13.661*** (0.433)	13.835*** (0.337)
Log (Price)	-0.400*** (0.062)	-0.551*** (0.081)	-0.604*** (0.112)	-0.456*** (0.092)	-0.494*** (0.073)
Trend	0.036*** (0.001)	0.035*** (0.001)	0.036*** (0.002)	0.036*** (0.001)	0.036*** (0.001)
R <sup>2</sup>	0.988	0.975	0.614	0.816	0.790
Adj. R <sup>2</sup>	0.987	0.972	0.611	0.814	0.788
Num. obs.	25	24	300	184	277
	without instruments				
Constant	16.460*** (0.273)	17.157*** (0.356)	14.731*** (0.487)	13.787*** (0.420)	13.764*** (0.326)
Log (Price)	-0.400*** (0.061)	-0.546*** (0.079)	-0.566*** (0.108)	-0.483*** (0.090)	-0.478*** (0.071)
Trend	0.036*** (0.001)	0.035*** (0.001)	0.037*** (0.002)	0.036*** (0.001)	0.036*** (0.001)
R <sup>2</sup>	0.988	0.975	0.614	0.816	0.790
Adj. R <sup>2</sup>	0.987	0.972	0.611	0.814	0.788
Num. obs.	25	24	300	184	277

Notes: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ . (1) Yearly aggregation covering February to January. (2) Yearly aggregation covering October to September. (3) All months from September 1889 to August 1914 included. (4) All months but not those possibly affected by storage. (5) All months but those identified in Table 1.

the threat of European imports affected US prices prior to 1903. Third, imports of the substitute saccharin in Austria-Hungary were banned. In sum, they solely estimate the residual demand faced by cane sugar refineries and thus do not incorporate competitive threats by imports and beet sugar. Furthermore, they do not take into account any stock-piling effect that might increase the short-run elasticity.

Inelastic demand leads to another central question: Why does the cartel not cut output in order to increase prices, revenues and thus profits? In equilibrium, a cartel

does not set a price in an area where demand is inelastic. Although I do not formally model competitive constraints like Salvo (2010), the narrative evidence clearly states that entry constrained the three refineries-only cartels. The second great cartel faced imports as a competitive constraint and the first great cartel did neither renegotiate nor adjust the net price during its six years' existence. It remains an open question whether problems in renegotiation, morality or political pressure led to this stable pricing.

## 5.4 Further Insights on Storage

Up to now, I have not taken into account the insights from the seasonal pattern of storage. In this section, I review some theory that relates to storage and the observed market structure. Then, I will estimate the storage effects based on seasonal dummies.

Initially, it is interesting to know why storage occurs. On the one hand, storage is costly: It has a physical storage cost, it binds capital and it carries the risk of depreciation of the inventory due to a change in price. On the other hand, there are some benefits. First, a certain amount of storage is the everyday business of retailers and wholesalers. Second, storage is an insurance against price volatility.<sup>87</sup> Third—and this is the most important point—storage allows intertemporal substitution of purchases which is especially relevant for all anticipated domestic price changes due to tax or cartel changes. This intertemporal substitution also interacts with the supply side: For 1889 to September 1891, I observe competition within an oligopolistic structure and a ban on presales. According to Anton and DasVarma (2005), each firm tries to capture future demand and thereby induces storage. If such initial competition for future demand exists, prices decrease and stronger sales occur early in the season.

For the period of the first cartel—October 1891 to September 1894—I observe a cartel that limits yearly sales but does not commit to a monthly release and decides in February

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<sup>87</sup>However, there is no reason why storage after the point of taxation should be a preferred insurance against price volatility that stems from world markets fluctuations—untaxed inventories of refineries are a better place to bet on higher world market prices, since only untaxed sugar can be exported. Thus only an insurance against volatility on the domestic mark-up above world market prices is desirable.

whether the planned amount of sales shall be increased. Dudine et al. (2006) analyze such a situation where a monopolist does not commit to future prices and thus induces storage. In that model, the buyer rationally anticipates the equilibrium in the second period in which the monopolist will increase future prices to the monopoly level—thus buyers store already in the first period so that a future price that ignores the intertemporal substitution is not profitable anymore. According to that theory, I also expect higher sales in the earlier period—and thus storage.

For the period of the first great cartel, the cartel decides on the monthly release of all sugar. The cartel releases a sufficient amount to supply current consumption but to prevent accumulation of inventories. This is in line with the monopolist who commits also to future prices and thus prevents social wasteful storage (Dudine et al., 2006). Under this theory and for the great cartel fixing the monthly release, I would expect a seasonal pattern that corresponds to consumption—if such a seasonal pattern in consumption exists.

From the end of the joint sales company to the start of the refinery cartel in 1906, I observe future contracts that enable a separation between the insurance against price changes and the physical storage service. For such a market structure, social wasteful storage is avoided (Anton and DasVarma, 2005). For the period of the refinery cartel from 1906 on, the cartel fixes the monthly release for refined sugar. However, there is competition for the sales of crystal sugar. Furthermore, for some years futures for crystal sugar are observed on the exchange. Thus I expect a sales pattern that corresponds to consumption but is somehow affected by competitive market structure for crystal sugar that might induce storage.

Finally, there is a second great cartel from 1911 on. However, some sales for crystal sugar are still done via forward contracts.

Table 5: Seasonal Dummies

	Jan 89 - Sep 94	Oct 97- Aug 03 Oct 11 - Jul 14	Nov 95 - Sep 97 Oct 06 - Sep 11	Sep 03 - Sep 06
Jan	0.246 (0.073)***	-0.021 (0.065)	-0.044 (0.069)	0.000 (0.079)
Feb	0.126 (0.073)	-0.108 (0.065)	-0.068 (0.069)	-0.137 (0.079)
Mar	0.128 (0.072)	0.009 (0.067)	0.165 (0.069)*	0.069 (0.072)
Apr	0.128 (0.072)	-0.036 (0.064)	-0.001 (0.072)	-0.106 (0.079)
May	-0.011 (0.075)	-0.026 (0.064)	-0.024 (0.069)	-0.048 (0.097)
Jun	-0.071 (0.075)	-0.064 (0.064)	-0.066 (0.069)	-0.095 (0.097)
Jul	-0.059 (0.075)	0.127 (0.064)*	0.105 (0.069)	0.076 (0.097)
Aug	-0.127 (0.075)	0.012 (0.064)	0.021 (0.069)	0.003 (0.097)
Sep	-0.398 (0.072)***	0.009 (0.065)	-0.016 (0.069)	-0.144 (0.097)
Oct	-0.164 (0.072)*	0.183 (0.065)**	0.051 (0.069)	0.017 (0.097)
Nov	0.384 (0.072)***	0.093 (0.065)	0.218 (0.069)**	0.251 (0.097)*
Dec	0.175 (0.073)*	0.035 (0.065)	0.127 (0.069)	

Notes: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . The dummies were added to model (5) without instruments in Table 4. Thus months affected by demand anticipation are excluded.

#### 5.4.1 Estimation of Seasonal Dummies

In order to analyze these effects, I reestimate the demand model without instruments and with a removal of all months that are affected by demand anticipation due to cartel or tax changes. I use a first set of dummies for the period January 1889 to September 1894—where I expect strong sales early in the season. I use a second set of dummies for the two phases of the first and second great cartel. A third set of dummies is estimated for the periods of refineries’ cartel that fix monthly release. A last set of dummies is used for the period with competition and forward contracts.

The results in Table 5 do not reject the theory that an oligopolistic market structure without presales and a cartel without commitment on future prices will induce storage: For the period 1889 to September 1894, the coefficient for the log sales for the “early months” November to April are positive, whereas the other months are negative. For the great cartels—1897-1903 and 1911-1914—I observe higher sales in July, October and November. This might coincide with higher demand due to fruit canning, wine making

and a traditional inventory demand for operational reasons in November. For the periods when only a refinery cartel was active but fixed monthly release, I observe higher sales in March, July, November and December. This corresponds to a sales pattern next to consumption although some sales are done in March. For the period September 1903 to September 1906, the only remarkable coefficient is in November when sales are higher again. December is the base period. To sum up, theories on storage are not rejected.

## 6 Estimation of Cartel Overcharges

The cartel always faced an inelastic demand and narrative evidence strongly suggests that entry, imports and lack of price adjustment restricted its pricing power. Thus I estimate the realized overcharges: I take the difference between the net of tax price in Vienna and the export price in Trieste including the export bounty and calculate the mean overcharge for those periods relative to the competition periods.<sup>88</sup>

Table 6: Estimate for Cartel Mark-up

K per 100 kg	Mark-Up		Import Duty	Mark-Up (in %) to Import Duty
	Est.	Std.Err.		
1 <sup>st</sup> Cartel 1891-1894	5.1	(0.5)	24.1	21.1%
2 <sup>nd</sup> Cartel 1895-1897	8.4	(0.6)	24.1	34.9%
1 <sup>st</sup> Great Cartel 1897-1903	14.1	(0.4)	24.1	58.5%
3 <sup>rd</sup> Cartel 1906-1911	3.6	(0.4)	5.7	63.1%
2 <sup>nd</sup> Great Cartel 1911-1914	9.6	(0.5)	5.7	168.4%

Notes: The difference between the net price in Vienna and the net price in Trieste is regressed on the time dummies for the cartel periods. The constant of 2.4 K captures the quality difference minus the transport costs.

Table 6 summarizes the estimated mark-ups compared to those periods where I do not observe cartels. All mark-ups are significantly different from zero.

<sup>88</sup>A formal pricing regression is presented in Table 8 in the appendix.

The first cartel among refineries fixed annual sales quotas and managed to increase the domestic net price by 5.1 K. Entering raw sugar factories lead to a dissolution in late 1894.

The second refineries' cartel explicitly fixed the price and monthly release, thereby reducing inventory demand. Still facing competitive pressure by entry, the mark-up rose to 8.4 K—roughly a third of the protective import duty. Meanwhile raw sugar factories engaged in local beet purchasing cartels and agreed on a joint cooperative in order to form a great cartel together with refineries. The restraint to exclusively deal within the cartel effectively impeded entry.

This first great cartel fixed the net of tax price once and for all subsequent six years. This strategy lead to an average mark-up of 14.1 K (58% of the protective import duty). Fixing the price for six years whereas export prices considerably varied led to strong variation of the mark-ups and even some imports in 1901.<sup>89</sup> The greatest challenge to the first great cartel was the Brussels Convention that harshly reduced import protection. In order to prevent individual members from deviating and gaining temporary outsider profits, a central exclusive joint sales office was implemented and notification rules on individual action were markedly increased. Despite spending money on media and convincing the parliament about the industry's necessity to regulate the industry in a cartel style manner, the Brussels Convention set an end to the first great cartel and to Eugen von Boehm Bawerk's law on industry regulation.

It took the industry three years to form another cartel among refineries—supported by an empire-internal trade barrier between Austria and Hungary. In order to deal with competitive pressure from domestic crystal sugar and imports, the cartel started to offer retroactive exclusivity rebates for individual customers. Monitoring of sales and imports outside the cartel was increased in 1909 when contract notes were made obligatory for resellers. This cartel had the lowest mark-up of on average 3.6 K—but in terms of the import protection, the mark-up increased further to roughly two thirds.

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<sup>89</sup>Hlawitschka (1902, p. 36)

The final stage of cartelization was reached in 1911 when a great cartel was reestablished that kept accounts on individual customers in order to grant retroactive exclusivity rebates. Supported by lobbying on protective freight rates, the cartel was able to increase the domestic price level in Vienna to 170% of the protective import duty.

## 7 Summary and Discussion

This paper presented a sequence of events on the sugar industry's failures and successes to cartelize, improvements in the collusive strategy and (anticipating) reactions to sustain collusion when external circumstances changed.

The introduction of the excise tax solved the monitoring problem in 1888. The first refineries' cartel suffered from excessive storage and entry, until the monthly release was fixed and entering raw sugar factories were integrated. A joint sales agency helped to sustain collusion for the remaining limited period of protective duties until the Brussels Convention took effect in 1903. After some years of competition, the cartel was reestablished in 1906. Retroactive exclusivity rebates impeded competing imports and sales of crystal sugar. The most sophisticated great cartel started in 1911 and reintegrated raw sugar factories. The cartel overcharge relative to the protecting import duty increased from 21.1% for the first cartel to 168.4% for the second great cartel (although the absolute maximum was reached during the first great cartel when the protective import duty still existed).

The study aims to reassess and refine existing economic theory and current antitrust practice. Based on my personal knowledge of the literature and antitrust practice, some issues stick out.

**Excise tax enables collusion.** The failure to form a cartel due to the lack of public information on production data in 1873/74 is in line with Harrington and Skrzypacz (2011) who find that sustainable collusion in a quota cartel requires truthful reporting of private information on sales. The introduction of the excise tax served as a monitoring

tool for the cartels later on. The industry requests reveal a preference for strict control and almost immediate release of information on aggregate sales.

To the best of my knowledge, current economic literature does not find that a specific excise tax increases market power by improving information exchange. The case of the sugar cartel shows that the tax incidence for a new specific excise tax and an inelastic demand might put more than 100% of the burden on consumers. Already late 19<sup>th</sup> century draft antitrust legislation in Austria-Hungary aimed to monitor industries with excise taxes and was supported by economic common sense expressed by Menger (1897) who supported the draft law as beneficial for the government and the consumer. Recent anticartel activity also addresses this issue. In Korea in 1991-2005, three sugar producers jointly determined their share of supply in the domestic market. The cartel exchanged information on the payment of a special excise tax in order to monitor compliance with the agreed-upon supply restrictions. When the special excise tax was abolished, cheating occurred.<sup>90</sup> Recent research (Kopczuk et al., 2013) finds for state diesel taxes that moving the point of tax collection from the retail station closer to the prime supplier raises the pass-through of diesel taxes as well as tax revenues. As an explanation, less tax evasion is suggested. The sugar excise tax enabling a cartel suggests a complementary explanation: A collusive strategy among more concentrated prime suppliers or distributors may increase their interest in strict control of sales in order to enhance monitoring capabilities.

**Organizational learning and inner workings.** Within five legal subsequent cartels, the sugar industry learned to overcome all central challenges that cartels face—monitoring, internal coordination and entry (Levenstein and Suslow, 2006). The learning was in line with current models on inner workings of cartels. The first challenge was cheating (Harrington and Skrzypacz, 2011)—the introduction of the excise tax in 1888 enabled perfect monitoring of sales. The first cartel faced storage inducing competition for future demand (Anton and DasVarma (2005) and Dudine et al. (2006))—the second

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<sup>90</sup>Ku and Lee (2012, p.3)



cartel fixed monthly sales to suppress storage outside the cartel and the first great cartel committed to a fixed future price. The first and second cartel faced entry of raw sugar factories—the first great cartel integrated raw sugar factories and paid compensations to foreclose entry. This is in line with Asker and Bar-Isaac (2014) who identify exclusionary practice and rewarding kick-back transfers as essential conditions for some damaging vertical practices. Centralizing sales and stronger notification duties were required to prevent deviations when the collusion game changed to finite repetitions due to the Brussels Convention. The harsh reduction of the import protection lowered the overall cartel gain in such a way that competition took place for some years—until a more sophisticated cartel was formed. This third refineries’ cartel started to keep accounts on individual customers in order to grant retroactive exclusivity rebates—another compensation to downstream customers to impede entry via imports (Asker and Bar-Isaac, 2014). Faced again with entry, the second great cartel re-integrated raw sugar factories.

The sheer size of the cartel—the refineries’ cartel included more than 30 refineries—confirms the idea put forward by Farrell (2000): Large cartels exist in an environment where explicit collusion is legal, central parameters as rival’s costs and the demand elasticity are known and renegotiations need not to be secret.

As in the US Sugar Institute (Genesove and Mullin, 2001), I observe efforts to increase transparency by early notification and obligatory documentation as well as dispute resolution mechanisms to legally verify deviating behavior. Furthermore, sales agents with high powered incentives to deviate were controlled by the central joint sales agency when the cartel anticipated increased instability due to the foreseeable end in 1903. In line with Genesove and Mullin, I found neither evidence on reversion to competition as a punishment device, nor any indications on problems with renegotiations of cartel rules after deviations occurred.

**Empirical evaluation of market power.** Empirically, demand turned out to be inelastic and did not constrain pricing power of the cartel. Aggregation to periods covering

an inventorying cycle turned out to be useful for demand estimation—even when the number of observations is cut to a twelfth.

Narrative evidence and inelastic demand show that the threat of entry and imports and the lack of price adjustment did restrict pricing power of the cartel. The former corresponds to Salvo (2010) who finds entry censored market power of Brazilian cement producers. Identifying competitive pressure from entry, imports and internal coordination within the cartel explains pricing power better than demand estimation.

Market power in terms of the limiting import constraint increased steadily. When the import protection was reduced, the cartel developed more sophisticated methods to foreclose competitors. The more time and experience the sugar cartel had, the better was the collusive strategy and its practical implementation.

**Policy conclusions.** Specific excise taxes deserve severe skepticism. For already existing taxes of this kind, the ministry of finances might review their information release policy towards the industry to reduce support for immediate monitoring of individual behavior. From an institution-building point of view, the excise tax supported by the industry initially solved the tax administration problem for sugar and helped to establish sound and stable financing for a government that resembles more a developing country in today's world. However, specifically within the first great cartel, the excise tax seemed more like a Pandora's box hurting consumers as well as the government when high prices not only damaged consumers but also reduced sugar consumption and thus sugar tax revenues—to the detriment of the government.<sup>91</sup> Only an outside interference—the Brussels Convention—was able to put an end to massive cartel gains by the industry.

The success of various markers for cartel detection depends on the specific organizational form of the cartel. Whereas the first great cartel did not pass on costs and the variance of prices was set to zero, the threat of entry or imports limited the other cartels'

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<sup>91</sup>The cartel increased the price during the first great cartel to 84 K per 100 kg. Assuming a competitive price of 70 K per 100 kg and an elasticity of -0.4, the price increase was 20% and the decrease in tax revenues was 8%.

pricing power and affected both cost pass-on as well as the variance of prices.

At last, the real world case of the sugar cartel shows that vertical exclusionary practices matter. The collusion with upstream raw sugar factories as well as the exclusionary retroactive rebates to downstream customers increased the pricing power of the cartel.

## References

- Anton, J. J. and DasVarma, G. (2005). Storability, Market Structure and Demand-Shift Incentives. *The RAND Journal of Economics*, 36(3):520–543.
- Arbeiterzeitung (1888-1914). Various issues.
- Asker, J. and Bar-Isaac, H. (2014). Raising Retailers' Profits: On Vertical Practices and the Exclusion of Rivals. *The American Economic Review*, 104(2):672–686.
- Auspitz, R. (1904). Wirtschaftliche Entwicklung. Vortrag gehalten in der Generalversammlung des Centralvereines für Rübenzuckerindustrie am 5. Juni 1904 in Wien. *Oesterr.-ungar. Zeitschrift für Zuckerindustrie und Landwirthschaft*, pages 532–543.
- Auspitz, R. and Lieben, R. (1889). *Untersuchungen über die Theorie des Preises*. Duncker und Humblot, Leipzig.
- Centralverein (1872-1888). Various issues. *Der Marktbericht: Organ für Handel und technischen Fortschritt der landwirthschaftlichen Gewerbe, vorzugsweise für Rübenzucker-Industrie, Spirituosen, Getränke und Consumtions-Artikel*.
- Centralverein (1888-1914). Various issues. *Wochenschrift des Centralvereines für Rübenzucker-Industrie in der Öst.-Ung. Monarchie*.
- Centralverein (1904). Der Centralverein für Rübenzucker-Industrie in der Österr.-Ungar. Monarchie (Verein für Rübenzucker-Industrie im Kaiserthum Österreich) 1854-1904: Festschrift anlässlich der Feier des fünfzigjährigen Bestandes des Vereines. Wien.
- Cleveland, R. B. et al. (1990). STL: A Seasonal-Trend Decomposition Procedure based on Loess. *Journal of Official Statistics*, 6:3–73.
- Dudine, P., Hendel, I., and Lizzeri, A. (2006). Storable Good Monopoly: The Role of Commitment. *American Economic Review*, 96(5):1706–1719.
- Farrell, J. (2000). Renegotiation In Repeated Oligopoly Interaction. *Incentives, Organization, and Public Economics: Papers in Honour of Sir James Mirrlees: Papers in Honour of Sir James Mirrlees*.
- Fink, N., Schmidt-Dengler, P., Stahl, K., and Zulehner, C. (2015). Registered Cartels in Austria. An Overview. *WIFO Working Papers*.
- Genesove, D. (2015). History in the Study of Industrial Organization. *Paper presented at the meeting of the European Association for Research in Industrial Economics, Munich, Germany*.
- Genesove, D. and Mullin, W. P. (1998). Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914. *The RAND Journal of Economics*, 29(2):355–377.
- Genesove, D. and Mullin, W. P. (2001). Rules, Communication, and Collusion: Narrative Evidence from the Sugar Institute Case. *American Economic Review*, 91(3):379–398.

- Griffin, C. F. (1902). The Sugar Industry and Legislation in Europe. *The Quarterly Journal of Economics*, 17(1):1–43.
- Handels- und Gewerbekammer Prag (1896). Denkschrift der Handels- und Gewerbekammer in Prag gerichtet an das k. k. Handelsministerium in Betreff der staatlichen Regelung des Cartellwesens. Prag.
- Hanreich, H. (1989). Wertungswandel im Wettbewerbsrecht. Habilitation thesis.
- Harrington, J. E. and Skrzypacz, A. (2007). Collusion under Monitoring of Sales. *The RAND Journal of Economics*, 38(2):314–331.
- Harrington, J. E. and Skrzypacz, A. (2011). Private Monitoring and Communication in Cartels: Explaining recent collusive Practices. *The American Economic Review*, 101(6):2425–2449.
- Hendel, I. and Nevo, A. (2004). Intertemporal Substitution and Storable Products. *Journal of the European Economic Association*, 22(2):536–547.
- Hendel, I. and Nevo, A. (2006). Measuring the Implications of Sales and Consumer Inventory Behaviour. *Econometrica*, 74(6):1637–1673.
- Hendel, I. and Nevo, A. (2010). A simple Model of Demand Anticipation. *Working Paper*.
- Hines, James R., J. (2008). Excise Taxes. In Durlauf, S. N. and Blume, L. E., editors, *"The New Palgrave Dictionary of Economics*. Palgrave Macmillan, Basingstoke.
- Hlawitschka, A. (1902). Das Wesen und die schädliche Wirkung des Zuckerkartells und der Rübenkartelle in Österreich-Ungarn. Wien.
- Hromada, E. (1911). *Die Entwicklung der Kartelle in der österreichisch-ungarischen Zuckerindustrie*. PhD thesis, Zürich.
- Hyytinen, A., Steen, F., and Toivanen, O. (2015). Anatomy of Cartel Contracts. *mimeo*.
- Ivaldi, M., Jullien, B., Rey, P., Seabright, P., and Tirole, J. (2003). The Economics of Tacit Collusion. *IDEI Working Paper*, 186.
- Kartell-Rundschau (1903-1911). Various issues. *Kartell-Rundschau: Monatsschrift für Recht und Wirtschaft im Kartell- und Konzernwesen*.
- k.k. Handelsministerium, editor (1912). *Verhandlungen der vom k.k. Handelsministerium veranstalteten Kartellenquete*, volume 1. Zuckerindustrie 27., 28., 29. Februar 1912, Wien. Hof-u. Staatsdr.
- Kohl, W. and Steiger-Moser, S., editors (2014). *Die österreichische Zuckerindustrie und ihre Geschichte(n) 1750-2013*. Böhlau, Wien.
- Kopczuk, W., Marion, J., Mühlegger, E., and Slemrod, J. (2013). Do the Laws of Tax Incidence Hold? Point of Collection and the Pass-through of State Diesel Taxes. *NBER Working Papers*, 19410.

- Kraus, K. (1899-1936). Various issues. *Die Fackel*.
- Ku, S. M. and Lee, J. R. (2012). Price Fixing Cartel by Three Sugar Manufacturers. *KFTC Decision NO. 2007-408*.
- Levenstein, M. C. and Suslow, V. Y. (2006). What determines Cartel Success? *Journal of Economic Literature*, 44(1):43–95.
- Mariusz Paździora (2008). Austria-Hungary 1914, physical. <http://commons.wikimedia.org/wiki/File:Austria1914physical.jpg>. CC BY 3.0.
- Menger, C. (1871). *Grundsätze der Volkswirtschaftslehre*. Willhelm Braumüller, Wien.
- Menger, C. (1897). Ein Gesetz gegen Kartelle. *Jahrbücher für Nationalökonomie und Statistik*, 14(3):113–115.
- Mühlpeck, V., Sandgruber, R., and Woitek, H. (1979). *Index der Verbraucherpreise, 1800 - 1914. Eine Rückberechnung für Wien und den Gebietsstand des heutigen Österreich*, pages 649–688. bearb. im Österr. Statistischen Zentralamt.
- Neue Freie Presse (1888-1914). Various issues.
- Öst.Akad.d.Wissenschaften (2005). Siegl, Eduard. *Österreichisches Biographisches Lexikon und Biographische Dokumentation*, 12.
- Pigman, G. A. (1997). Hegemony and Trade Liberalization Policy: Britain and the Brussels Sugar Convention of 1902. *Review of International Studies*, 23(02):185–210.
- Pindyck, R. S. (2001). The Dynamics of Commodity Spot and Futures Markets: A Primer. *The Energy Journal*, 22(3):1–29.
- Prager Zuckermarkt (1906). Various issues.
- Resch, A. (2002). *Industriekartelle in Österreich vor dem Ersten Weltkrieg. Marktstrukturen, Organisationstendenzen und Wirtschaftsentwicklung von 1900 bis 1913*, volume 84 of *Schriften zur Sozial- und Wirtschaftsgeschichte*. Duncker und Humblot, Berlin.
- Roth, K. and Lück, E. (2011). Ein Molekülschicksal. Die Saccharin-Saga. Teil 1. *Chem. Unserer Zeit*, 45:406–423.
- Rudolph, R. L. (1973). *Quantitative Aspekte der Industrialisierung in Cisleithanien 1848-1914*, pages 233–249. Verlag der Österreichischen Akademie der Wissenschaften.
- Salvo, A. (2010). Inferring Market Power under the Threat of Entry: The Case of the Brazilian Cement Industry. *The RAND Journal of Economics*, 41(2):326–350.
- Schaal, D. (2005). *Rübenzuckerindustrie und regionale Industrialisierung*. Number 4 in *Forschungen zur neuesten Geschichte*. Münster.
- Schulze, M.-S. (2000). Patterns of Growth and Stagnation in the late nineteenth Century Habsburg Economy. *European Review of Economic History*, 4(3):311–340.

- Siegl, E. (1879). Zur Zuckersteuerfrage. *Organ des Central-Vereins für Rübenzucker-Industrie in der österreichisch-ungarischen Monarchie. Zeitschrift für Landwirtschaft und technischen Fortschritt der landwirtschaftlichen Gewerbe, vorzugsweise für Rübenzucker-Industrie*, (17):953–966.
- Stammer, K. (1887). *Lehrbuch der Zuckerfabrikation*. F. Vieweg und Sohn.
- Walker, F. (1903). The Sugar Situation in Austria. *Political Science Quarterly*, 18(4):565–598.
- Williams, J. C. and Wright, B. D. (1991). *Storage and Commodity Markets*. Cambridge University Press.
- w/o (1886). Motivenbericht zum Gesetzentwurfe, betreffend die Zuckerbesteuerung. *Organ des Central-Vereins für Rübenzucker-Industrie in der österreichisch-ungarischen Monarchie. Zeitschrift für Landwirtschaft und technischen Fortschritt der landwirtschaftlichen Gewerbe, vorzugsweise für Rübenzucker-Industrie*, (24):467–474.
- w/o (1897). Übereinkommen der Genossenschaft der österreichisch-ungarischen Zuckerfabriken mit mehreren anderen Firmen.

# A Appendix

## A.1 First Stage of Demand Estimation

Table 7: First Stage of 2SLS explaining the logarithmic real Price in Vienna

	(1)	(2)	(3)	(4)	(5)
Constant	0.150 (0.498)	0.545 (0.486)	0.530*** (0.118)	0.945*** (0.144)	0.563*** (0.116)
Trend	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)
Price Trieste, Bounty, Tax	0.976*** (0.115)	0.884*** (0.113)	0.890*** (0.028)	0.793*** (0.034)	0.883*** (0.027)
Cartel 1891-1894	0.077** (0.026)	0.080** (0.027)	0.079*** (0.008)	0.101*** (0.009)	0.080*** (0.008)
Cartel 1895-1897	0.144*** (0.027)	0.130*** (0.027)	0.132*** (0.008)		0.128*** (0.009)
Cartel 1906-1911	0.071* (0.029)	0.057 (0.028)	0.055*** (0.009)	0.056*** (0.010)	0.059*** (0.009)
Cartel 1897-1903	0.204*** (0.019)	0.207*** (0.019)	0.202*** (0.006)	0.217*** (0.007)	0.205*** (0.006)
Cartel 1911-1914	0.148** (0.039)	0.126** (0.038)	0.125*** (0.011)	0.110*** (0.014)	0.128*** (0.012)
R <sup>2</sup>	0.951	0.953	0.928	0.948	0.938
Adj. R <sup>2</sup>	0.931	0.932	0.927	0.947	0.937
Num. obs.	25	24	300	184	277

Notes: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ . (1) Yearly aggregation covering February to January. (2) Yearly aggregation covering October to September. (3) All months from September 1889 to August 1914 included. (4) All months but not those possibly affected by storage. (5) All months but those identified in Table 1.

## A.2 Cartel Pricing Regression

In order to explain the price in Vienna, I would optimally run the following regression:

$$P_V = \alpha_0 + \alpha_1 P_T + \alpha_2 b + \alpha_3 t + \alpha_4 f + \alpha_5 CARTEL + \epsilon \quad (3)$$

Time series for the price in Trieste,  $P_T$ , the export bounty,  $b$ , and the tax,  $t$  are available. The freight costs,  $f$  are not available in a regular form. Thus I lack an explanatory variable. The different competitive regimes,  $CARTEL$ , are captured by dummy variables for the different cartel forms and periods. Furthermore, I include an interaction term for the price in Trieste and for the period of the first great cartel 1897 to 1903, when the



price was fixed and the variation in Trieste did not influence the price in Vienna during that period.

Table 8: Regression, Dependent Variable: Price in Vienna

	(1)	(2)	(3)	(4)	(5)
Constant	2.819 (3.106)	3.855** (1.358)	5.903*** (1.360)	-39.643*** (2.888)	10.675** (3.418)
Price in Trieste	1.002*** (0.024)			1.044*** (0.029)	
Tax	1.044*** (0.048)			1.136*** (0.057)	
Export Bounty	1.331*** (0.272)			5.220*** (0.229)	
Price Trieste, Bounty, Tax		0.978*** (0.021)	1.006*** (0.021)		0.970*** (0.052)
Price in Trieste for 97-03	-1.003*** (0.086)	-0.993*** (0.075)	-1.062*** (0.073)	0.022 (0.027)	
Cartel 1891-1894	4.233*** (0.457)	5.099*** (0.393)	4.360*** (0.403)		
Cartel 1895-1897	7.804*** (0.631)	8.233*** (0.475)	8.272*** (0.456)		
Cartel 1897-1903	39.348*** (2.766)	39.707*** (1.947)	41.924*** (1.915)		
Cartel 1906-1911	5.242*** (0.538)	3.721*** (0.351)	5.366*** (0.461)		
Cartel 1911-1914	11.624*** (0.852)	9.752*** (0.430)	11.946*** (0.589)		
Trend	-0.103 (0.088)		-0.156*** (0.030)	1.087*** (0.062)	
R <sup>2</sup>	0.953	0.948	0.953	0.900	0.536
Adj. R <sup>2</sup>	0.951	0.947	0.951	0.898	0.535
Num. obs.	307	307	307	307	307

Notes: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ . For all regressions in (1-5), the price in Vienna is the dependent variable. For the included explanatory variables, the coefficient are presented in the respective column.

Table 8 gives the results for different specifications. In model (1) and (4), I do estimate different coefficients for the tax, the export bounty and the price in Trieste. A priori, all coefficients should be next to one. The coefficient for the price in Trieste fulfils that criterion. For the tax and the export bounty, I have to reject that for model (4). For model

(1), I cannot reject the null hypothesis that the coefficients equal one. Still, I reject the model due to the coefficient for the export bounty that is against my a priori knowledge. Thus I conclude that both models are misspecified. In essence, (1) and (4) capture the higher cartel mark-ups before the Brussels Convention due to the higher import duty. The export bounty was abolished when the Brussels Convention came into force, thus it also captures the variation due to the lowered import duty. Due to arising collinearity, I cannot add another dummy for the Brussels Convention. To deal with this problem, I add up the observed opportunity costs—the price in Trieste, the tax and the export bounty—and thus restrict them to one coefficient. In model (5), I regress the price simply on the observed opportunity cost. The coefficient is not significantly different from one, thus this model works fine. However, I do not estimate the cartel mark-ups, thus only 53.6% of the variance is explained. Model (2) and (3) have both an R-Square of around 95%. The restriction to one coefficient for the opportunity cost does not—as expected—lead to a significant loss of information, since an F-Test comparing the models (1) and (3) is not significant. All coefficients in (2) and (3) confirm the knowledge on price formation. The opportunity cost is not different from one, the price in Trieste is subtracted with a coefficient not different from one for 1897-1903, all cartels have significant mark-ups. The mark-up for the first great cartel 1897-1903 is so large since the price is fixed and thus the price in Trieste is subtracted from the opportunity cost. The only difference is the significant trend of -0.156. This says that the price in Vienna declined by 3.75 K relative to Trieste over 25 years. I do not have any indications that support such a strong decline—thus I choose model (2) as my favorite model. The coefficient of 0.978 is slightly smaller than one. Due to lower net weight in Vienna and a tax credit, this seems realistic.<sup>92</sup> The constant of 3.855 K can be interpreted as an average higher price in Vienna that results from higher quality in Vienna minus the additional transport cost to Trieste.

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<sup>92</sup>k.k. Handelsministerium (1912, p. 189)